WORK PLAN FOR ADDITIONAL ON-PROPERTY VAPOR INTRUSION ASSESSMENT

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WORK PLAN FOR ADDITIONAL ON-PROPERTY VAPOR INTRUSION ASSESSMENT
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1.0 INTRODUCTION AND BACKGROUND

On behalf of Texas Instruments Incorporated (TI), Langan Treadwell Rollo presents this *Work Plan for Additional On-Property Vapor Intrusion Assessment* (Work Plan) for TI's campus located at 2900 Semiconductor Drive in Santa Clara, California (Figure 1). This Work Plan was prepared at the request of the United States Environmental Protection Agency (USEPA) and California Regional Water Quality Control Board, San Francisco Bay Region (Water Board) via email on 5 December 2013. On 5 December 2013, the Water Board transmitted a letter dated 3 December 2013, which presented guidelines for on-property vapor intrusion assessment. The scope of the assessment and methodologies proposed are based on subsequent discussions between TI, the Water Board, and the USEPA. USEPA and Water Board have requested that a vapor intrusion assessment be completed for all occupied buildings located on TI's Santa Clara campus (on-property) shown on Figure 2 (USEPA, 2013). The scope presented in this Work Plan includes Buildings A, B, C, G, M, W, and 39 based upon the TCE concentration contours illustrated on Figure 3 and building use. Buildings A, B, M, and W have not been previously assessed. Buildings C, G, and 39 have been recently assessed in late 2012 and early 2013 and are included for a 2nd round of testing. Other on-property buildings D, E, F, 9, and 19 are not proposed to be sampled as part of this scope, because they are either unoccupied or previous indoor air sampling results do not indicate that a vapor intrusion risk exists.

The vapor intrusion assessment work plan for off-property (downgradient) buildings to the north was submitted separately to the USEPA and Water Board, on 29 October 2013. A revised and updated off-property work plan is currently being prepared.

TI's campus was formerly owned and operated by the National Semiconductor Corporation (NSC). In 2011, NSC was acquired by TI, and TI assumed environmental responsibility for the residual soil and groundwater contamination present on the campus. In July 1987, the former NSC site was listed on the National Priorities List (NPL) of sites subject to regulation under the

federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as the federal "Superfund" act). Under agreements with the USEPA, the Water Board provides lead regulatory oversight at the site. The buildings currently proposed for sampling are located within the footprint of Operable Unit 1 (OU1), Subunit 1, as defined in the USEPA Record of Decision dated 18 September 1991 (the ROD), which is generally bounded by Kifer Road to the south, the City of Sunnyvale/Santa Clara boundary to the west, East Arques Avenue to the north, and portions of the Lawrence Expressway to the east. The location and specific boundary of OU1, Subunit 1 is illustrated on Figure 4. This Work Plan is organized as follows:

- Section 1 – Introduction and Background
- Section 2 - Building Survey and Inventory
- Section 3 - Sampling and Analysis Plan
- Section 4 - Quality Assurance Project Plan
- Section 5 - Health and Safety Plan
- Section 6 - Data Evaluation, Reporting, and Schedule
- Section 7 - References

Additional site background is presented below.

1.1 Site Background

TI's Santa Clara campus occupies approximately 67-acres and is bordered by Central Expressway to the north, Kifer Road to the south, office buildings along San Ysidro Way to the east, and other industrial/commercial buildings to the west (on-property, TI's campus, or the site, Figure 1). TI's campus consists of 13 buildings and a parking garage. All the buildings are surrounded by paved parking areas and/or landscaping. TI's campus and buildings are located in Subunit 1 of OU1 (Figure 4). Building 39 is currently leased to Premier One Credit Union and is not occupied by TI employees, although TI does own the land. The remainder of the buildings located on TI's campus are either occupied by TI or are unoccupied.

Prior to 1960, the site was used primarily for agricultural cultivation. In the 1960's, General Microelectronics and Molectro conducted semiconductor research and/or small-scale semiconductor manufacturing on the eastern portion of the site. These operations ceased after several years. NSC occupied a portion of the facility and began manufacturing semiconductors in 1967. In addition, Nortech conducted similar operations on portions of the site from 1968 to 1977. With its acquisition of NSC, TI acquired the campus in September 2011. The site is currently used for research and development and general administration (i.e., offices).

From 1982 to 1991, NSC conducted site-wide assessments of contaminant source areas in Subunit 1, which were documented in a report prepared by Harding Lawson and Associates in 1991 (HLA, 1991). Volatile organic compound (VOC) contamination was found in the site soil and groundwater. Residual VOCs previously impacted soil and the two uppermost hydrologic units (A- and B-aquifers) at the site due to releases from underground storage tanks, sumps, and pipes.

The investigation and remediation of the site is currently under the jurisdiction of the Water Board and the USEPA. The Final Site Cleanup Requirements are detailed in Water Board Orders 91-137, 91-139, and 91-140, and the USEPA Record of Decision, which were issued in September 1991. Originally, 12 soil source units were identified in the Water Board Orders on TI's campus (the Tank T13 and Leak L5 areas were previously identified as one source area). The locations of the former source areas are illustrated on Figure 2. Eleven of these 12 soil units have been identified as requiring no further action by the Water Board. The Leak L5 Area, which is associated with Building C, is the last remaining soil source area in the Soil Operable Unit requiring closure (Treadwell & Rollo, 2006). Significant remediation has taken place at the Leak L5 Area beneath Building C in recent years, including soil vapor extraction, soil excavation and disposal, and chemical oxidation. The remedial efforts at the Leak L5 Area have significantly reduced the contaminant mass associated with this area.

1.1.1 Geology

The site is underlain by a thick layer of unconsolidated quaternary alluvial sediments, which were deposited by primarily northward flowing streams draining from the Coast Range Mountains. Alluvial sediment deposits range from approximately 500 to 1,200 feet thick and consist of clays and silts interlayered with sands and gravels. The sand and gravel layers range from 1 foot to over 20 feet thick. The alluvial sands and gravels become finer and contain more

clay and silt towards the ground surface. This trend is the result of a decrease in depositing stream energy as the area became filled with sediments and stream gradients decreased. Paleochannels consisting of more permeable sands and gravels were formed in the direction of the depositing streams in the south to north direction. The paleochannels act as preferential paths for groundwater flow. Bedrock underlies the alluvial sediments (HLA, 1991).

1.1.2 Hydrogeology

Depth to groundwater at the site generally ranges from 8 to 15 feet beneath ground surface (bgs). The A-aquifer is locally unconfined or partially confined, and separated from the underlying B-aquifers by a low permeability clay aquitard. There are areas where the A- and B-aquifers appear to be hydraulically connected. Historically, the subsurface in OU1 has been subdivided into the following general shallow aquifer units (Treadwell & Rollo, 2006):

- The A-aquifer, typically found between 5 to 30 feet bgs;
- The B1-aquifer, typically found between 30 to 45 feet bgs;
- The B2-aquifer, typically found between 45 to 60 feet bgs; and
- The B3-aquifer, typically found between 70 to 90 feet bgs.

A groundwater elevation contour map for the A-aquifer in OU1 illustrating general flow directions is shown on Figure 4.

1.1.3 Site Contamination

VOCs, including chlorinated solvents and aromatics, make up the majority of chemicals detected in site soils and in groundwater, although semi-VOCs have been detected historically in isolated locations at the site (Treadwell & Rollo, 2006).

VOC concentrations are greatest in the A- and B1-aquifers, with some VOCs detected at low concentrations in the B2-aquifer. VOCs have not been generally detected in groundwater samples from the B3- and deeper aquifers in OU1 (Treadwell & Rollo, 2006).

As approved by the Water Board, the following indicator chemicals were identified to define the extent of chemicals in the A- and B-aquifers (Treadwell & Rollo, 2006):

- TCE;

- cis-1,2-dichloroethene (cis-1,2-DCE);
- 1,1,1-trichloroethane (1,1,1-TCA);
- 1,1-dichloroethene; and
- trichlorotrifluoroethane (Freon 113).

Other chemicals historically or currently detected in groundwater samples from the A- and B-aquifers include (Treadwell & Rollo, 2006; Treadwell & Rollo, 2012; and Stantec, 2012):

- tetrachloroethene (PCE),
- trans-1,2-dichloroethene,
- vinyl chloride,
- 1,1,2-trichloroethane,
- 1,1-dichloroethane,
- 1,2-dichloroethane,
- chloroethane,
- dichloromethane,
- chloroform,
- 1,2,3-trichlorobenzene,
- 1,2,4-trichlorobenzene,
- 1,2-dichlorobenzene,
- 1,3-dichlorobenzene,
- 1,4-dichlorobenzene,
- chlorobenzene,
- toluene,
- ethylbenzene,
- xylenes, and
- trichlorofluoromethane.

Groundwater monitoring results for 2013 are presented in Table 1. A TCE concentration contour map for the A-aquifer is shown on Figure 3. The above chemicals of concern will be analyzed in sub-slab vapor, indoor air, and ambient air samples proposed in this work plan.

1.2 Fate and Transport Mechanisms and Potential Exposure Pathways

Fate and transport mechanisms for VOCs may include migration in groundwater, adsorption to soil and organic matter in the subsurface, volatilization and migration in soil gas (advection and diffusion through the vadose zone), and volatilization and migration to air. VOCs may also accumulate beneath building foundations, in building crawl spaces and basements, and in preferential pathways such as utility corridors or elevator shafts.

1.2.1 Potential Exposure Pathways

Potential exposure pathways for VOCs to reach receptors include the following:

- **Construction Excavations:** Workers may be exposed via potential inhalation during excavation activities in areas overlying VOC-impacted groundwater at the site. Construction workers may encounter contaminated water during subsurface repairs or installation or maintenance of underground utilities. The potential exposure to VOCs, during construction projects, would be limited by health and safety planning and implementation.

- **Water Supply:** The site is not a source of water supply and there are currently no water supply wells at the site. Therefore, the water supply pathway is not complete. The potential exposure to groundwater from any future water supply wells at the site is limited by the deed restriction in place at the site.

- **Indoor Air Inhalation:** Commercial workers occupying current site buildings may be exposed to VOC vapors off-gassing from the groundwater plume. This pathway will be evaluated as part of this vapor intrusion assessment.

- **Underground Utilities:** VOCs in soil gas at the site generally migrate along the path of least resistance (e.g. preferential pathways). Underground utility trenches are typically backfilled with more permeable material than the surrounding soil, which would create a preferential pathway. VOC vapors may move along underground utilities such as storm drains and sanitary sewers quicker than through the native soil at the site. This pathway will be evaluated as part of this vapor intrusion assessment by visually identifying and measuring air quality near slab penetrations within the buildings proposed for sampling.

1.2.2 Potential Receptors

Potential receptors at the Site include current and future workers occupying site buildings and construction workers disturbing the subsurface.

1.3 Summary of Previous Soil and Groundwater Remediation Activities

Significant mitigation and remediation activities have been ongoing at the site since the mid-1980s and have been detailed in numerous technical reports. Ongoing groundwater extraction and treatment at the site has been successful in maintaining the current boundaries of the plume. In addition to groundwater extraction and treatment, chemical oxidation, bioremediation pilot studies, soil vapor extraction and soil excavation have been completed at the site. These remedial activities have resulted in significant contaminant reductions both on- and off-campus.

A summary of the previous remediation activities and current conditions at Buildings A, B, C, G, M, W, and 39 are provided below.

1.3.1 Building A

Building A is located north of Kifer Road and east of Buildings C and M (Figure 2). Four contamination source areas were identified in proximity to Building A: Tank T9, Tank T10, Leak L6 and Leak L7 Areas. SVE was implemented at these areas from 1993 to 1996 to address shallow soil contamination. A total of 1,527 pounds of VOCs were removed with these systems. Closure for these source areas was requested in April 1996 and granted by the Water Board in July 1997.

1.3.2 Building C

Building C is located north of Kifer Road (Figure 2). Three contamination source areas were identified in proximity to Building C during a 1991 investigation: Tank T12, Tank T13, and Leak L5 Areas. SVE was implemented at the Tank T12 source area between 1992 and 1994 to address shallow soil contamination. In 1995, soil cleanup goals were attained at Tank T12 and the SVE system operation was discontinued as approved by the Water Board (Treadwell &Rollo, 2006). Less than 10 lbs of VOCs were removed from the Tank T12 source area and no further action was required by the Water Board.

SVE was also implemented at the Tank T13 and Leak L5 source areas. Soil cleanup goals were attained at the Tank T13 Area and SVE operation was discontinued in March 2005. The Water Board concluded that 'no further action' is required with regard to assessment or remediation at the Tank T13 Area in June 2010 (Treadwell & Rollo, 2006). SVE operation at the Leak L5 source area was discontinued in March 2005, due to reduced system effectiveness. SVE operation at the Tank T13 and Leak L5 source areas resulted in the combined removal of more than 23,400 lbs of VOCs.

Approximately 1,440 tons of impacted soil exceeding the cleanup criteria for VOCs (1,000 micrograms per kilogram) was excavated from the Leak L5 source area between 21 December 2009 and 2 January 2010. Soil exceeding the cleanup criteria was delineated prior to excavation activities. Due to equipment limitations associated with interior nature of the work and the shallow depth to groundwater, soil could only be removed to a maximum depth of 11

feet bgs. The Leak L5 area is the last remaining soil source area in the Soil Operable Unit requiring closure at the site.

A chlorinated VOC plume is present beneath the footprint and downgradient of Building C. PCE, TCE, cis-1,2-DCE, 1,1-dichloroethane, dichlorobenzenes, ethylbenzenes, and xylenes have been detected in groundwater above cleanup levels. To address existing groundwater contamination beneath and downgradient of Building C and residual soil contamination in the capillary fringe, chemical oxidation treatment has been implemented. Klozur® Activated Persulfate (manufactured by FMC) along with a sodium hydroxide activator was injected across the footprint of the 2009-2010 excavation at the Leak L5 source area. Three injection events were conducted in March 2012, July 2012, and June 2013 with approximately 7,000 gallons of persulfate injected during each event. Water quality cleanup standards have not yet been achieved, though significant reductions in total VOC concentrations have occurred. Additional injection activities are anticipated to further reduce VOCs beneath and downgradient of Building C. As of August 2013, the highest PCE and TCE concentrations detected in groundwater beneath Building C are 400 and 310 µg/L, respectively in well CWI-17.

1.3.3 Building G

Building G is located at the former locations of Buildings 2, 3 and 4. The parcel associated with Building G is bordered to the east by San Ysidro Way, to the north by Tahoe Way, to the west by Semiconductor Drive, and to the south by Kifer Road (Figure 2). Three source areas were identified in this area during investigations documented in 1991, including: Sump S3 located north of former Building 2, Tank T2 located west of former Building 3, and Tank T3 located in the alley south of former Building 3 and north of former Building 4 (Figure 2).

SVE was implemented at the Tank T2 and Tank T3 source areas to address shallow soil contamination around 1992. SVE was discontinued in 1998 pending soil closure activities in the source areas. NSC requested soil closure in 1999 (HLA, 1999). On 23 June 2000, the Water Board approved the request submitted by NSC on 27 April 2000, for permanent closure of the SVE system in operation at Buildings 2, 3, and 4 due to the fact that VOC concentrations were below cleanup levels at Tank T2, Tank T3, and Sump S3 source areas, and VOC removal rates had declined to very low levels (Water Board, 2000).

NSC implemented ozone sparging (OS) for treatment of the saturated zone in the Tank T2 and Tank T3 areas in 2000 (SECOR, 2000). An ozone sparging system with vapor capture using SVE was installed during construction of Building G which currently overlies the Tank T2 and Tank T3 source areas. NSC expanded the OS/SVE system into the parking lot of Building G prior to completion of the building (SECOR, 2002). The OS/SVE system operated from 2002 to 2008. OS beneath Building G in the T2 and T3 source areas was discontinued in 2007 based on the results of a limited Geoprobe® investigation documenting that groundwater concentrations for total VOCs were below 500 µg/L (SECOR, 2007).

OS treatment was halted in the Building G parking lot in 2008 due to limited treatment effectiveness in the former Sump S3 source area and equipment problems. Elevated concentrations of ethylbenzene and xylenes, low permeability clay soils, and a low density of treatment wells are believed to have contributed to the limited effectiveness of OS in the Sump S3 source area. NSC implemented Fenton's Reagent remediation in the Sump S3 source area in 2009 (Stantec, 2010). Fenton's Reagent was found to have limited effectiveness in the low permeability soils. In response, NSC conducted a pilot study to evaluate enhanced in situ bioremediation in 2011 and 2012 (Stantec, 2011 and 2012). NSC selected SiREM Laboratories (SiREM) KB-1-Plus microbial inoculum to enhance TCE, 1,1,1-TCA, and chlorobenzene biodegradation. Preliminary results of the pilot study indicate that the treatment can be effective in remediating chlorinated VOCs in the former Sump S3 source area (Stantec, 2012).

Based on the most recent groundwater data, the highest groundwater concentrations in the Building G area are in the northern parking lot (Stantec, 2012). TCE concentrations have been greatly reduced in the Building G area since remedial activities have been implemented. However, as TCE is dechlorinated, concentrations of its breakdown products, cis-1,2-DCE and vinyl chloride, have increased significantly. Based on the most recent data, the highest concentrations of TCE, cis-1,2-DCE, and vinyl chloride in the area downgradient of Building G are 1,700, 5,100 and 500 µg/L, respectively (Table 1), although this appears to be limited to a very small area. Elevated levels of xylenes and ethylbenzene have also been detected in this area at concentrations of 124,000 and 27,000 µg/L, respectively (Table 1).

1.3.4 Building 39

Building 39 is located immediately north of intersection of San Ysidro Way and Tahoe Way (Figure 2), and downgradient of the former Sump S3 source area located north of Building G.

Based on the most recent and closest data collected, TCE concentrations in groundwater beneath Building 39 are likely less than 100 µg/L. Ongoing groundwater extraction and treatment at OU1, as well as in-situ remedial methods at the former Sump S3 source area, have been successful in maintaining or decreasing the current boundaries of the VOC plume, but groundwater cleanup goals have not been met to date in all wells.

1.3.5 Buildings B, M, and W

No source areas were identified at Buildings B, M, or W and therefore, no environmental remediation activities have been performed specifically at these buildings. Ongoing groundwater extraction and treatment at OU1 have been successful in maintaining or decreasing the current boundaries of the VOC plume, but groundwater cleanup goals have not been met to date in all wells.

1.4 Previous Vapor Intrusion Assessments

In 2003, the Water Board requested an evaluation of the vapor intrusion pathway for the site using both the new USEPA provisional and CalEPA adopted TCE cancer slope factor. In response, NSC collected indoor air, ambient air, and soil gas samples from Buildings 19, 39, A, B, E, and the solvent pad located between Buildings E and 19. These buildings were selected based on their downgradient location relative to existing or former source areas. Indoor air samples were also collected from Building C following the remedial excavation in 2010 (Section 1.3.2). Recent soil vapor intrusion assessments (2004 Focused Risk Assessment, 2006, 2007, 2010 Indoor Air Testing at Building C, and 2012/2013 Vapor Intrusion Assessments) are discussed in the following sections.

The indoor air results presented are compared to the short-term and long-term screening levels listed in Table 2, which are established by the Agency for Toxic Substances & Disease Registry (ATSDR), the USEPA, and the Water Board.

1.4.1 2004 Focused Risk Assessment

In 2004, NSC conducted a focused risk assessment to evaluate the potential for vapor intrusion across the 67-acre campus (Treadwell & Rollo, 2004). Indoor air, soil gas, and ambient air samples were collected at six buildings located on the campus (including Buildings 19, 39, A, B, E, and the solvent pad). Previous sampling results for each location are summarized in Table 3

and sampling locations are shown on Figure 5. The objective and scope of work associated with the focused risk assessment included:

- Collecting indoor air samples from selected buildings downgradient of former sources;
- Collecting ambient air samples near the intakes of the heating, ventilation, and air conditioning (HVAC) systems at buildings where indoor air samples were collected to evaluate potential non-groundwater sources of chemicals in indoor air;
- Collecting soil gas samples to develop soil gas-to-indoor air attenuation factors;
- Analyzing the indoor air, ambient air and soil gas samples for VOCs; and
- Evaluating the data and preparing a report.

Of the few chemicals detected in indoor air testing, most were detected at concentrations similar to that of outside ambient air. None of these chemicals were detected in soil gas (Table 3).

The *Focused Risk Assessment* incorporated a screening-level evaluation of detected chemicals in each building, regardless of the potential source. The evaluation included a commercial worker receptor and a theoretical residential receptor even though the campus is limited to commercial land use. The 2003 Water Board indoor air ESLs for residential and commercial land were used as a comparison point to calculate excess cancer risks and noncancer hazards.

Overall, no commercial or residential total chemical excess cancer risks for any of the buildings exceeded a value of 1E-06, a general regulatory point of departure for the evaluation of risk management measures. Excess cancer risks less than 1E-06 are considered by regulatory agencies to be insignificant. None of the noncancer hazards for each of the buildings exceeded the threshold value of 1. Noncancer hazards less than 1 indicate that there is no risk of noncancer health hazards. Since TCE was not detected in any of the indoor air samples, no adjustment of the TCE ESL using the USEPA provisional cancer slope factor was required to develop excess cancer risk estimates (Treadwell & Rollo, 2004). Additionally, the results of our 2004 evaluation were compared to the updated 2008 ESLs and applicable RSLs and no exceedances were identified.

1.4.2 2006 and 2007 Indoor Air Sampling Activities at Building C

Indoor and outdoor air sampling activities were performed at Building C on 28 September 2006 and on 13 September 2007. The samples were collected in 6-liter SUMMA canisters equipped with 8-hour regulators pre-set by the analytical laboratory. These air samples were collected to evaluate indoor air conditions during normal business hours (when Building C is occupied). Outdoor air (vented into Building C through the HVAC system) was also tested at the intake locations. Indoor and ambient air sample locations are illustrated on Figure 5.

The 2006 and 2007 sampling results are summarized in Table 3. The detected concentrations were compared to commercial-use ESLs. The 2006 data was previously presented in the Remedial Alternatives Evaluation (Treadwell & Rollo, 2006).

In 2006, benzene and carbon tetrachloride were detected in all three samples collected, including the outdoor sample. The benzene and carbon tetrachloride values of the indoor samples were similar to the values of the outside control samples. Also, benzene and carbon tetrachloride were not present in soil or groundwater, nor were these compounds used at Building C. The concentrations of benzene and carbon tetrachloride are representative of background concentrations reported.

In 2006, PCE was detected in indoor air samples A-2 and A-3 at 0.25 micrograms per cubic meter ($\mu g/m^3$) and 0.76 $\mu g/m^3$. The 0.76 $\mu g/m^3$ detection slightly exceeds the ESL for commercial indoor air of 0.68 $\mu g/m^3$ (Table 3). PCE was detected in outdoor air sample A2 at 0.22 $\mu g/m^3$. The concentrations of PCE are likely representative of background concentrations reported in the literature.

A subsequent indoor air sampling event was performed on 13 September 2007. The sample locations are illustrated on Figure 5. During the 2007 sampling event, all detected concentrations were below their respective commercial ESLs (Table 3).

1.4.3 2010 Indoor Air Testing at Building C

Indoor air testing was conducted following the remedial excavation at the Leak L5 Area at Building C on 4 January 2010 (Treadwell & Rollo, 2010). At that time, the remedial excavation was complete and the area had been backfilled and compacted but the slab had not been replaced at the time of indoor air testing. The excavation area was separated from other parts

of the building by permanent walls and temporary visqueen "walls" over walkways and doorways.

Three indoor air samples were collected in summa canisters using 8-hour flow controllers. One sample was collected in the excavation area (Sample A), one sample was collected outside the excavation area on the same floor (Sample B), and one sample was located on the second floor in the stairway (Sample C).

The results of this indoor air sampling event were provided to the Water Board in the *Leak L5 Area Remedial Closure Report* by Treadwell & Rollo dated 25 May 2010. The indoor air results were compared to Water Board ESLs for commercial air quality criteria and the RSLs for commercial/industrial land use (Table 3). Neither of the two samples collected outside of the excavation area had VOC concentrations exceeding either the ESLs or RSLs. The sample collected inside the excavation area had no chlorinated VOCs above ESLs or RSLs but did have concentrations of benzene, toluene, ethylbenzene, and total xylenes detected at concentrations exceeding commercial indoor air ESLs. However, these detected concentrations were very likely associated with residual exhaust fumes from excavation and compaction equipment used two days prior to sample collection.

Building C indoor air will be sampled as part of this vapor intrusion assessment. Toluene, ethylbenzene, and xylenes will be analyzed as part of this vapor intrusion assessment because they have been detected in the subsurface; however, benzene is not proposed for analysis since this compound has not been detected in the subsurface at the site and is very likely associated with equipment and vehicle exhaust. A complete list of contaminants proposed for analysis is presented in Section 1.1.3.

1.4.4 2012 and 2013 On-Property Vapor Intrusion Assessments

An on-property vapor intrusion assessment was conducted on TI's campus between November 2012 and April 2013 in consultation with the USEPA and Water Board. All work was conducted in general accordance with the Work Plan dated 4 December 2012. The overall objective of this assessment was to evaluate whether VOCs present in the soil and groundwater beneath the site are migrating from the subsurface into indoor air at levels that may pose a risk to site workers or occupants. The assessment consisted of the collection of 68 indoor air, 23 pathway air, six ambient air and 19 sub-slab vapor samples (including duplicates) from seven buildings

(Buildings 9, 19, 39, C, E, F, and G) located on the TI campus in Santa Clara. The analytical results for indoor, pathway, and ambient air samples are summarized in Table 4 and the analytical results for the sub-slab samples are summarized in Table 5.

The indoor air sample results were compared to the USEPA RSLs for industrial air quality criteria and the Water Board ESLs for commercial air quality criteria. The results indicate that indoor air sample concentrations are below USEPA and Water Board screening criteria and vapor intrusion is not significantly impacting indoor air quality in occupied spaces with the HVAC units operating in all the buildings sampled.

Building E

The only sample location with concentrations above USEPA RSLs and Water Board ESLs with HVAC units operating was a pathway sample collected from the subterranean tunnel located beneath Building E. TCE was detected in the tunnel pathway sample at 16 $\mu g/m^3$. No action was recommended with respect to this exceedance since the tunnel is unoccupied, inspected briefly once a quarter by facility personnel and a very limited number of employees have access to this locked area. However, TI is in the process of installing signage at the tunnel access points notifying potential tunnel occupants of the potential risk associated with entry and evaluating potential sealing approaches to mitigate the vapor intrusion. Additionally, a sample was collected in the mechanical room which is the only interior access point to the tunnel and no ESL or RSL exceedances were detected with HVAC on or off. If the tunnel is utilized in the future, potential conduits (sump, floor drains, slab penetrations for utilities, etc.) in the tunnel would be properly sealed and confirmation testing of the indoor air performed prior to occupancy. All other compounds detected were below the ESLs and RSLs at all locations with HVAC on and off or were not detected in the subsurface; therefore, no further action was recommended in Building E.

Building 39

In 2013, all indoor air sample results were below the USEPA RSLs and Water Board ESLs with HVAC systems operating. Chloroform, TCE, and PCE were detected in one pathway sample with HVAC off in Building 39 above screening levels. All detections in this pathway sample with HVAC on were below screening levels. However, additional preferential pathway assessment and mitigation measures, including sealing penetrations and conduits, have been

implemented to address this issue. Confirmation air sampling was performed on 28 April 2013, which showed an average 48% decrease in TCE, PCE, and chloroform concentrations. TCE concentrations decreased from 27 to 16 µg/m^3, PCE concentrations decreased from 6.2 to 3.2 µg/m^3, and chloroform concentrations decreased from 3.5 to 1.6 µg/m^3. The additional testing proposed at Building 39 will further evaluate the effectiveness of the sealing of the conduits and the current indoor air concentrations.

Building C

No ESL or RSL exceedances were detected in Building C with HVAC systems operating normally. PCE was detected above its ESL at four of the seven indoor air sample locations with HVAC off. No other compounds were detected with HVAC systems on or off. The highest PCE concentration detected with HVAC off was 18 µg/m^3. All PCE detections in Building C with HVAC on were below its ESL. Following the initial rounds of indoor air sampling, a preferential pathway evaluation was completed, which identified interior monitoring wells, janitor closet slab penetrations and an elevator pit for sealing. The interior monitoring wells had the well boxes replaced and sealed with Liquid Boot®. The janitor closet slab penetrations were also sealed with Liquid Boot®. The elevator pit was cleaned and sealed with an epoxy coating. Additionally, active soil and groundwater remediation activities are occurring beneath Building C which have significantly reduced concentrations of VOCs in the subsurface. The follow up sampling proposed in Building C will evaluate the effectiveness of the sealing activities which have taken place since the last sampling event.

Buildings 9, 19, F, and G

Several indoor air, pathway air and ambient air samples were collected from Buildings 9, 19, F, and G with HVAC systems on and off. All compounds were detected below the ESLs and RSLs at all locations with HVAC on and off or were not detected in the subsurface; therefore, no further action was recommended in these buildings.

Buildings 9 and 19 are currently unoccupied and there are no plans to reoccupy these buildings at this time. Furthermore, it is unlikely these buildings will be reoccupied and they will likely be demolished. Samples collected with HVAC on and off from Building F were similar in concentration which indicates that vapor intrusion is not likely significantly impacting indoor air quality. No additional sampling is proposed at Buildings 9, 19, or F.

Confirmation sampling is currently proposed at Building G at the same previously approved sample locations with HVAC on and off.

1.5 Problem Definition

Based on the shallow groundwater level at the site, and the VOC concentrations in groundwater, the USEPA and Water Board have requested that additional vapor intrusion assessment be completed on TI's campus (USEPA 2013). As discussed in the Section 1.0 of this work plan, the vapor intrusion assessment is currently proposed to take place at on-property buildings that are occupied and where the potential for vapor intrusion exists. The on-property vapor intrusion assessment scope will include collecting and analyzing indoor air, pathway air, sub-slab vapor (where previous sub-slab data is not available) and ambient air samples from Buildings A, B, C, G, M, W, and 39, as detailed in this Work Plan. The indoor, pathway, and ambient air sampling locations will remain consistent for the previously sampled Buildings C, G and 39. The sample locations from these buildings were collaboratively selected with representatives from the USEPA and Water Board and were previously approved.

The number of samples and specific locations for Buildings A, B, M, and W were determined during the building surveys completed with representatives from the USEPA and Water Board on 21 February 2014. Our proposed sample locations were submitted to the USEPA and Water Board via email transmittal on 26 February 2014 following the building survey. Sample locations proposed for all buildings are presented on Figures 6 through 16.

The vapor intrusion survey at Buildings A, B, C, G, M, W, and 39 will include the following work elements:

- Conducting a building survey and inventory with USEPA and/or Water Board representatives at Buildings A, B, M, and W, which was completed on 21 February 2014. Buildings C, G, and 39 were previously surveyed with representatives from the USEPA and Water Board and the sample locations previously approved.

- Collecting indoor air and pathway samples over a period of 10 hours from Buildings A, B, C, G, M, W, and 39 with HVAC system operating normally.

- Collecting indoor air and pathway samples over a period of 10 hours from Buildings A, B, C, G, M, W, and 39 with the HVAC system turned off for a minimum of 36 hours prior to initiating sample collection.

- Collecting sub-slab (or near-slab where slab thicknesses exceed 12 inches) vapor samples from Buildings A, B, M, and W to assess sub-surface VOC concentrations and to develop site-specific sub-slab-to-indoor air attenuation factors.

- Collecting ambient air samples near the intakes of the HVAC systems at or near buildings where indoor air samples were collected to evaluate potential non-groundwater sources of chemicals in indoor air.

- Analyzing the indoor, pathway, ambient air, and sub-slab/near-slab vapor samples for VOCs previously detected in the sub-surface.

- Evaluating and documenting the data in a technical memorandum.

2.0 BUILDING SURVEY AND INVENTORY

Building surveys were completed at Buildings A, B, M, and W to identify appropriate indoor and ambient air and sub-slab vapor sampling locations. The surveys were conducted on 21 February 2014, in the presence of the USEPA and Water Board case managers. Buildings C, G, and 39 were previously surveyed with representatives from the USEPA and Water Board on 14 November 2012. During the building surveys the following information was documented and/or inventoried:

- Building exterior and interior observations;

- Chemical use and storage;

- Presence of floor drains;

- Concrete slab conditions;

- Presence of HVAC units and operational areas;

- Operational parameters for HVAC units;

- Workers and type of work conducted in the building;

- Potential alternative indoor contaminant sources; and

- Presence of potential preferential pathways for soil vapor migration.

Field screening was conducted using a photoionization detector (PID) – ppbRAE Plus – with a detection limit in the low parts per billion (ppb) range as part of the building survey to further

evaluate potential vapor intrusion pathways and identify locations with the greatest vapor intrusion potential. Potential preferential pathways for soil vapor migration include gaps and cracks in building foundations, piping, utility lines, and dewatering systems. Slightly elevated PID readings were observed at chemical storage areas and at the chiller blow down drain located in the mechanical room at Building A. Areas with heightened VOC concentrations were recorded on field logs and used to identify indoor and pathway air and sub-slab sample locations.

Building layout plans for Buildings A, B, C, G, M, W, and 39 are illustrated on Figures 6 through 16 and show the distinct air handling areas and the current interior layouts for each building. This information was used to approximate areas of similar air composition during the selection of sampling locations.

Proposed indoor air sample locations were chosen based upon the PID survey results and historical source areas, if applicable. Indoor air samples are identified as areas of the buildings normally occupied by employees or contractors throughout the day.

Proposed pathway samples were also chosen based upon the PID survey results and are proposed for collection near janitor closets and elevators and former source areas, as these areas represent possible preferential pathways for vapor intrusion and areas with the highest sub-slab VOC concentrations. It should be noted that employees do not occupy areas with pathway samples proposed regularly.

Sub-slab sample locations were selected based on former source area locations, anticipated or known slab thickness, areas where slab coring is feasible and to also provide spatial coverage of the building. The proposed indoor air, pathway air and sub-slab sample locations are presented on Figures 6 to 16.

A survey questionnaire of building condition, use, and chemicals present at all the buildings with the exception of Building 39 was completed by TI. No building survey was obtained (although requested) for Building 39, which is occupied by the Premier One Credit Union. The completed building surveys and inventory forms are included in Appendix A.

2.1 Building Descriptions

A brief description of each building and current usage is provided below and summarized in Table 6.

Building A

Building A is a two-story slab on-grade commercial/industrial building with approximately 110,000 total square feet of interior space, which primarily consists of office space and research labs (Figures 6 and 7). The concrete foundation is reinforced with steel and is several feet thick in most places due to its former use as a fabrication facility. Several areas of the building are utilized as 'clean room' laboratories and have an epoxy sealant/coating on the concrete floors, which were applied during renovation activities in 2011 and 2012. There are three distinct air handling areas on the first floor (Figure 6) and three distinct air handling areas on the second floor (Figure 7) of Building A. The testing laboratories located in the southern portion of Building A are located on a raised floor system that is elevated approximately 1.5 feet above the building slab. Due to the nature of work conducted in Building A, the HVAC systems associated with the first floor operate continuously 24 hours per day, 7 days a week. Therefore, no HVAC off samples will be collected at Building A.

Based on the building surveys, three (3) indoor air samples, five (5) pathway samples including four on the first floor and one on the second floor, and one (1) sub-slab sample have been proposed for Building A.

Building B

Building B is an approximately 20,800 square feet, one-story slab on-grade commercial building, which primarily consists of kitchen and cafeteria space (Figure 8). The concrete foundation is reinforced with steel and the thickness of the floor slab is anticipated to vary between 6 inches and a foot. There are two distinct air handling areas and five supply air areas (associated with the gas stoves and ovens in the kitchen) in Building B (Figure 8). The HVAC systems in this building operate from 4 AM to 3 PM due to cafeteria occupancy patterns. The air supply units are associated with the stoves and ovens in the kitchen area.

Based on the building surveys, three (3) indoor air samples, three (3) pathway samples, and two (2) sub-slab samples have been proposed for Building B.

Building M

Building M is located between Buildings A and C and is a two story, slab on-grade building with approximately 12,000 square feet of total interior space (Figure 13). The floor of the first floor is covered by an epoxy sealant/coating, which was applied during renovation activities in 2011 and 2012. There are two distinct air handling areas on the first floor and three distinct air handling areas on the second floor in Building M. Based on the building survey, two (2) indoor air samples, one pathway air sample (on the second floor) and one (1) near-slab sample have been proposed for Building M. Due to the nature of work conducted in Building M, the HVAC systems associated with the first floor operate continuously 24 hours per day, 7 days a week. Therefore, no HVAC off samples will be collected at Building M.

Building W

Building W is located on the far western portion of TI's campus, to the west of Building C, and is a two story, slab on-grade building with approximately 45,000 square feet of total interior space (Figures 14 and 15). There are three distinct air handling areas on the first floor and two distinct air handling areas on the second floor of Building W. The shipping and receiving portion of the building is not ventilated, as the overhead doors are typically open and the space is heated by natural gas heaters. Based on the building survey and observations, five (5) indoor air samples on the first floor, one (1) pathway sample, and one (1) near-slab sample have been proposed for Building W. A near sub-slab sample (Figure 14) has been proposed because the slab associated with Building W is several feet thick. The second floor of Building W is not occupied and therefore, no samples are proposed on the second floor.

2.2 Previously Sampled Building Descriptions

Building C

Building C is a two-story, flat-roofed, slab on-grade commercial/industrial building with approximately 140,000 total square feet of interior space, which primarily consists of office space and research labs (Figures 9 and 10). The concrete foundation is reinforced with steel and the thickness of the floor slabs varies between 6 inches to several feet. There are eight distinct air handling areas on the first floor of Building C (Figure 9). There are six distinct air handling areas on the second floor of Building C, including one area with multiple air handling unit influences (Figure 10).

Based on the previous building surveys and air sampling conducted in 2012 and 2013, five (5) indoor air samples, and (4) pathway samples (including three on the first floor and one on the second floor) have been proposed for Building C.

Building G

Building G is a slab on-grade, three floor office building with approximately 140,000 square feet of total interior space (Figures 11 and 12). Building G formerly consisted of NSC's corporate headquarters, with all of the space used as offices and cubicle areas. Building G is currently unoccupied but will likely be occupied again in the future. Building G was constructed around 2000 and replaced former Buildings 2, 3, and 4. The underground piping, wells, and other equipment associated with the previous SVE and ozone injection/sparging system remain in place beneath Building G. Building G has six air handling units servicing the first floor and four air handling units servicing the second floor of the building.

Based on the previous building survey and the air sampling conducted in 2012 and 2013, four (4) indoor air samples, and four (4) pathway samples (including three on the first floor and one on the second floor) have been proposed for Building G.

Building 39

Building 39 is located to east of Building 9 and is a 15,000 square foot, single story, slab on-grade building owned by TI (Figure 16). This building is currently occupied by Premier One Credit Union, and will require coordination with that tenant for access. There are six distinct air handling areas in Building 39. Based on the previous building survey and the air sampling conducted in 2012 and 2013, three (3) indoor air samples and two (2) pathway samples have been proposed for Building 39.

3.0 SAMPLING AND ANALYSIS PLAN

Indoor air, pathway, and ambient air sampling will be conducted at Buildings B, C, G, W and 39 under both HVAC on and off conditions. Buildings A and M will only be sampled with HVAC systems operating because the HVAC units run continuously in Buildings A and M. Sub-slab or near-slab sampling will only be conducted at Buildings A, B, M, and W, where sub-slab samples have not been previously collected. Sub-slab sampling will be conducted within one week of indoor air and ambient air sampling. All building-specific HVAC on samples (indoor, pathway

and ambient air) will be conducted on the same day for each building during normal business hours over a 10-hour period. All building-specific HVAC off samples (indoor, pathway, and ambient air) will be conducted on the same day for each building over a 10-hour period. HVAC off samples will be collected following a minimum period of 36 hours without HVAC operation. Sub-slab sampling will likely require completion over the weekend in order to minimize disturbance to TI employees.

The following sections outline the sample collection methodology, analytical methods, field documentation, and quality control measures to be implemented. Specific sampling locations were determined in the field with Water Board and USEPA representatives and are included in this Work Plan. The proposed number and type of samples to be collected at each building are presented in Table 7 and also outlined in Section 2.0 of this report.

3.1 Sub-Slab and Near-Slab Vapor Sample Collection

Sub-slab vapor samples will be collected to assess the sub-slab VOC concentrations, to develop building specific slab attenuation factors and to be able to assess potential indoor sources of VOCs. Where sub-slab sampling is not feasible due to a thick building slab, presence of a vapor barrier, specialized floor coating, elevated floor, disturbance to building tenants or operations is not acceptable, near-slab samples will be collected adjacent to the building, underneath a paved surface to measure soil gas concentrations close to the building. Sub-slab and near-slab samples are proposed near former source areas, if possible. The proposed number and type of samples to be collected at each building are presented in Table 7.

Sub-slab and near-slab samples will be collected using Vapor Pins™ manufactured by and in accordance with Cox-Colvin and Associates Incorporated's Standard Operating Procedure Installation and Extraction of the Vapor Pins™ (Appendix B) and in general accordance with the California Department of Toxic Substances Control's (DTSC's) documents titled "Advisory – Active Soil Gas Investigation" dated April 2012 and "Final, Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air" dated October 2011. Vapor Pins™ allow for easy installation and removal and provide an air-tight seal between the slab and the exterior of the pin. New silicone sleeves will be used at each sample location and discarded following the initial use.

Sub-slab and near-slab vapor samples will be collected from agreed upon areas inside and adjacent to buildings proposed for indoor air sampling as described above. Sampling will be conducted as follows and as illustrated on Figure 17:

- Identify sample location with USEPA and Water Board and gain concurrence;
- Drill 5/8-inch hole through slab;
- Clean out drill hole and install the Vapor Pin™;
- Allow at a minimum, a two hour equilibrium time prior to purging and sampling;
- Perform shut-in test to test for leaks in the sampling system;
- Purge sampling location using a 60 milliliter (mL) luer lock syringe;
- Perform leak testing by introducing a known concentration of tracer gas (i.e., helium) in a shroud and using a helium detector to test for seal leaks; and
- Collect sub-slab vapor VOC grab-samples into pre-evacuated 1-liter summa canisters using flow controllers set to a maximum rate of 200 milliliters per minute (mL/min).

Sub-slab and near-slab vapor samples will be collected into clean, laboratory-supplied summa canisters, while using a sealed shroud to facilitate leak testing. Helium will be used as a tracer gas during field sampling to confirm leakage did not occur during sampling. The sampling system will be sealed within a shroud and a known concentration of helium (typically about 20% by volume) will be added inside the shroud and maintained at this concentration during sampling. Helium concentrations will be tested at the laboratory to verify the quality of the field sampling program. In addition to laboratory testing, field instrumentation will be used to evaluate whether leakage is occurring by testing pre-sample purge gas. If a leak is detected, an adjacent location will be selected for sampling. Sub-slab and near-slab vapor samples will be analyzed for VOCs detected in groundwater as detailed in Section 1.1.3 and Section 3.5. Following the sample collection, the summa canisters will be delivered to a State of California-certified laboratory for analysis of selected VOCs by low-level TO-15 (SIM). Sub-slab and near-slab sample results will be evaluated by applying a slab attenuation factor to the applicable Regional Screening Level (RSL) or Environmental Screening Level (ESL). USEPA has recently published a study that supports using a sub-slab attenuation factor of 0.01 for these compounds (USEPA, 2012b). However, this empirically-derived sub-slab attenuation factor is

based on data collected at residential properties. Alternative site-specific attenuation factors will be developed, for greater accuracy, if data permits.

3.2 Indoor and Pathway Air Sample Collection

Indoor and pathway air samples are proposed for collection to evaluate potential vapor intrusion pathways at Buildings A, B, C, G, M, W, and 39 and to determine whether VOCs are migrating from the subsurface into these buildings at levels that may pose a risk to site workers or occupants. Indoor air sample results will be compared to the USEPA RSLs for industrial air quality criteria and the Water Board ESLs for commercial air quality criteria.

The proposed number and location of the indoor air samples were based on the following rationale:

- Indoor air sample locations are proposed in buildings on the TI campus which have a potential vapor intrusion risk and are currently occupied or have plans to be reoccupied;
- Indoor air sample locations are proposed for each distinct air handling area and/or in areas of unrestricted air flow (i.e. cubicle areas with no dividing walls);
- Indoor air sample locations are proposed in areas with elevated PID readings and areas identified as former source areas;
- Pathway sample locations are proposed at identified preferential pathways (i.e., over seams in floor slabs, voids around piping penetrations, etc.) and are defined as areas that are not normally occupied during normal business hours; and
- Pathway air sample locations are proposed on second floor stairways to evaluate if any vapors are migrating from the first floor to the second floor.

All indoor air and pathway samples will be collected using a 6-liter summa canister with a 10-hour flow controller provided by the laboratory. The 10-hour sample will be collected from the general breathing zone (i.e., 3 to 5 feet above finished-floor level) during both normal HVAC building operating conditions (i.e. between 6 AM and 7 PM) and after the HVAC has been turned off for 36 hours. Note that Building B is the cafeteria and the HVAC typically runs from 4 AM to 3 PM and therefore, indoor and pathway air samples will be collected between these times. At the same time that the indoor air samples are collected, meteorological observations will be noted on field forms. Following sampling, meteorological data will be downloaded from the Santa Clara weather station. Meteorological data will be presented in the report. Indoor air

and pathway samples will be analyzed for VOCs detected in groundwater as detailed in Section 1.1.3.

If any of the indoor air results exceed applicable ESLs or RSLs, the need for additional sampling, assessment, and potential mitigation will be proposed and discussed with USEPA and the Water Board.

3.3 Ambient Air Sample Collection

Due to the multitude of influences on indoor air quality, ambient air samples will be collected near the intakes of HVAC systems at buildings where indoor air samples are to be collected to evaluate potential non-groundwater sources of chemicals in air. Ambient air samples will be collected on the same day as the indoor air sampling at each building and will be started about one hour prior to the start of the corresponding indoor air sample collection. Ambient air samples will be analyzed for VOCs using the same laboratory methods proposed for the indoor air samples.

Ambient air samples will be collected following the same methodology outlined for indoor air sampling presented in Section 3.2.

Up to 14 ambient air samples (including QC samples) will be collected to evaluate indoor air sample results in both HVAC on and off conditions. The number of ambient air samples will be dependent on the number of buildings sampled for indoor air per day. At least one ambient air sample will be collected per day. If adjacent buildings are proposed for sampling on the same day, one ambient air sample may be collected for adjacent buildings (i.e. Buildings A and M). Ambient air samples will be collected near the HVAC intakes of the buildings sampled.

3.4 Quality Control Sample Collection

The purpose of collecting field quality assurance/quality control (QA/QC) samples is to demonstrate the reliability and defensibility of the data and to assess the consistency of the overall sampling effort, including collection, transport, and analysis. Field QC samples will include field duplicate samples. Field duplicate samples are two samples collected at the same time, from the same source at the same depth and sample location as the associated field sample. Field duplicates are submitted to the project laboratory as separate samples ("blind"). The purpose of submitting blind duplicate samples is to assess the consistency or precision of

the laboratory's analytical system. Indoor air, pathway, ambient, and sub-slab field duplicates will be collected at a frequency of 10%, or one per laboratory submittal, whichever is greater.

The USEPA and Water Board may also choose to provide Performance Evaluation (PE) samples located adjacent to existing sample locations for performance evaluation purposes. The PE samples will be spiked with known concentrations of chemicals of concern. The PE samples, if provided, will be submitted to the project laboratory along with the primary samples to assess the precision and/or accuracy of the laboratory.

3.5 Analytical Methods

Samples will be analyzed for VOCs using method TO-15 analysis with selective ion monitoring (SIM) for VOCs detected in groundwater at the Site, as listed in Table 2. The list of contaminants of concern (COCs) and their respective laboratory reporting limits for low-level TO-15 (SIM) analysis are presented in Table 2.

3.6 Sample Identification

Sample nomenclature shall be assigned, as follows:

- Sub-slab vapor samples shall be sequentially identified as SS(sample number)-(building ID)-year-month-date (e.g., SS1-C-2014-03-05, the first sub-slab sample collected at Building C on 5 March 2014).
- Indoor air samples shall be sequentially identified as IA(sample number)-(building ID)-year-month-date (e.g., IA2-C-2014-03-15, the second indoor air sample collected at Building C on 15 March 2014).
- Ambient air samples shall be sequentially identified as AA(sample number)-(building ID)-year-month-date (e.g., AA1-A-2014-03-06, the first ambient air sample collected at Building A on 6 March 2014).
- Pathway samples shall be sequentially identified as PS(sample number)-(building ID)-year-month-date (e.g., PS1-G-2014-03-16, the first ambient air sample collected at Building G on 16 March 2014).

Duplicate sample nomenclature is sequentially as DUP(sample number)-(building ID)-year-month-date (e.g., DUP1-B-2014-03-05, the first duplicate sample collected at Building B on 5

March 2014). The primary sample and duplicate sample ID pairs will be recorded in the field logs.

3.7 Field Documentation

Field activity logs will be completed for each site visit. Field activity logs shall identify the following: site name and address, date and time onsite, onsite field personnel, general weather conditions, purpose of site visit, a summary of field activities, and any other important details.

In addition to field activity logs, air sampling logs will be completed to track sampling information. The following information will be included on air sampling logs: sample ID, sample type, sample location, date of sample collection, time of sample collection, sample canister number, flow-controller number, start/stop time, and name of sampler(s).

Photographs will be taken at each sampling location. A photograph log will be completed to identify the contents of each photo. The field documentation will be kept in the project files.

3.8 Chain of Custody

Samples will be collected and transported to the analytical laboratory following chain of custody (COC) procedures. The COC documents the identity and integrity of the sample from the time of collection through receipt at the laboratory. The COC will be completed as samples are collected, and will include the following information: sample ID, date of sample collection, time of sample collection, sample type, and sampler name(s). Additionally, the starting and ending pressures for the summa canisters should be noted on the COC form.

3.9 Sample Packing and Shipment

Samples will be packed in boxes and transported, by shipment or courier, to the analytical laboratory. Each sample will be individually labeled and will be accompanied by the COC. All samples will be transported to the analytical laboratory within 24 hours of sample collection. Sample delivery will be coordinated with the laboratory 48 hours in advance to ensure timely and safe delivery. The COC will be signed by the sampler and relinquished to the sample custodian.

3.10 Investigation Derived Waste

Investigation derived waste will be limited to used PPE and sampling equipment (i.e., gloves and tubing scraps). Investigation derived waste will be placed in garbage bags and properly disposed of offsite.

4.0 QUALITY ASSURANCE PROJECT PLAN

A Quality Assurance Project Plan (QAPP) has been prepared and is included as Appendix C. The QAPP is consistent with elements described in the *Guidance for Quality Assurance Project Plans (EPA240/R-02/009)* (USEPA, 2002). The QAPP has been prepared to ensure that the appropriate type, quality, and quantity of data is collected to meet project objectives.

5.0 HEALTH AND SAFETY PLAN

A site-specific Health and Safety Plan (HSP) has been prepared and is included as Appendix D. The HSP has been prepared in accordance with 29 Code of Federal Regulations 1910.120 and California Code of Regulations 5192. The HSP presents site-specific physical and chemical hazards expected to be encountered at the site, including chemicals previously detected in groundwater. The HSP also presents emergency contacts, a hospital route map and procedures to follow in the case of an emergency.

6.0 DATA EVALUATION, REPORTING, AND SCHEDULE

The indoor air and pathway sample results will be compared to corresponding Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs), USEPA RSLs (EPA, 2013), Water Board ESLs (Water Board, 2013) for industrial air quality criteria,. The COCs and respective MRL, RSL, and ESL screening levels are presented in Table 2. A summary of sampling activities and analytical results, as well as an evaluation of results will be provided in a technical report. The technical report will be completed following receipt of laboratory analytical results and submitted to the Water Board and USEPA.

At the request of the USEPA, the laboratory results will be emailed to USEPA and Water Board representatives within fourteen (14) calendar days of the receipt of validated data from the laboratory[1]. Additionally, any indoor air analytical results exceeding indoor air MRLs, RSLs,

[1] If problems with the laboratory report are identified during the data validation, the laboratory may be requested to re-issue the analytical report.

ESLs, RALs will be transmitted within seven (7) calendar days of the receipt of the validated data from the laboratory. The report documenting the results of this assessment will be available six to eight weeks following the receipt of the laboratory data.

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TABLES

Table 1
Groundwater Analytical Results, October 2013
Operable Unit 1
Texas Instruments
Santa Clara, California

Chemical Name			1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2,3-TCB	1,2,4-TCB	1,2-DCB	1,2-DCA	1,3-DCB	1,4-DCB	Carbon Disulfide	Chloro-benzene	Chloroform	cis-1,2-DCE	Ethyl-benzene	Freon 113	m,p-Xylenes	MTBE	O-Xylene	PCE	trans-1,2-DCE	TCE	Vinyl Chloride	All Other VOCs	Perchlorate
	Unit		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Well ID	Sample Date	DUP																									
Cleanup Standard (µg/L)			**200**	--	**5**	**6**	--	--	**60**	--	--	**5**	--	--	**5**	**6**	**68**	**1,200**	**175**[A]	--	**175**[A]	**5**	**10**	**5**	**0.5**	--	--
A-Aquifer Wells																											
11A	10/15/13		0.6	< 0.5	**9.5**	2.7	< 0.5	3.7	3.7	< 0.5	0.5	0.9	< 0.5	< 0.5	< 0.5	1.7	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	3.5	0.5	4.1	< 0.5	ND	NA
18A	10/15/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**15**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	1	**12**	< 0.5	ND	NA
21A	10/15/13		< 0.5	< 0.5	4.1	3.2	< 0.5	0.6	0.9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**59**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	1.2	1.5	**100**	**2.3**	ND	NA
	10/15/13	DUP-1	< 0.5	< 0.5	4.2	3.6	< 0.5	0.6	0.9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**58**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	1.2	1.1	**96**	**2.4**	ND	NA
30A	10/15/13		1.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**18**	< 1.0	7.4	< 1.0	< 1.0	< 1.0	**6.8**	< 1.0	**110**	< 1.0	ND	NA
32A	10/16/13		< 1.7	< 1.7	**5.8**	3	< 1.7	< 1.7	4.9	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**220**	< 1.7	65	< 1.7	< 1.7	< 1.7	2.5	4.1	**84**	**30**	ND	NA
	10/16/13	DUP-2	< 1.7	< 1.7	**5.1**	2.4	< 1.7	< 1.7	4.4	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**200**	< 1.7	61	< 1.7	< 1.7	< 1.7	2.5	3	**79**	**28**	ND	NA
38A	10/16/13		1.1	< 0.5	1.3	0.7	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	1.7	< 0.5	1.1	< 0.5	ND	NA
39A	10/15/13		4.2	< 1.7	**12**	< 1.7	< 1.7	25	**61**	< 1.7	89	**250**	< 1.7	25	< 1.7	**28**	< 1.7	< 6.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**18**	ND	NA
44A	10/17/13		1.1	< 0.5	1	0.7	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.7	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	1.6	< 0.5	0.5	< 0.5	ND	NA
46A	10/16/13		3.7	< 3.6	**10**	< 3.6	< 3.6	< 3.6	< 3.6	< 3.6	< 3.6	< 3.6	< 3.6	< 3.6	< 3.6	**220**	< 3.6	15	< 3.6	< 3.6	< 3.6	< 3.6	3.9	**610**	< 3.6	ND	NA
48A	10/16/13		< 1.7	< 1.7	4.8	2.5	< 1.7	< 1.7	5.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**190**	< 1.7	110	< 1.7	< 1.7	< 1.7	2.5	2.9	**87**	**25**	ND	NA
50A	10/16/13		< 0.7	< 0.7	4.7	1	< 0.7	< 0.7	3.6	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	**140**	< 0.7	< 2.9	< 0.7	< 0.7	< 0.7	< 0.7	3.1	**6.5**	**74**	ND	NA
58A	10/16/13		< 2.5	< 2.5	**5.1**	4.2	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	**100**	< 2.5	12	< 2.5	< 2.5	< 2.5	< 2.5	3.2	**500**	< 2.5	ND	NA
62A	10/15/13		5.9	< 0.5	3.1	1.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**46**	< 0.5	4.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**58**	< 0.5	ND	NA
68A	12/23/13		0.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	4.1	< 0.5	5.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	ND	NA
69A	12/23/13		0.6	< 0.5	< 0.5	0.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.7	6.5	< 0.5	3.9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**41**	< 0.5	ND	NA
70A	10/16/13		< 1.7	< 1.7	2.9	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**140**	< 1.7	6.8	< 1.7	< 1.7	< 1.7	< 1.7	1.8	**250**	< 1.7	ND	NA
72A	10/16/13		< 1.7	< 1.7	**7**	2.3	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**250**	< 1.7	< 6.7	< 1.7	< 1.7	< 1.7	2.4	2.8	**230**	< 1.7	ND	NA
89A	10/15/13		2.7	2	**48**	**14**	< 0.5	< 0.5	36	1.4	< 0.5	< 0.5	< 0.5	2.1	< 0.5	**8.4**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	**60**	2.1	**35**	ND	NA
101A	10/16/13		< 0.5	< 0.5	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**9.3**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	4.7	< 0.5	ND	NA
103A	10/16/13		< 1.3	< 1.3	1.4	1.8	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	**48**	< 1.3	7.4	< 1.3	< 1.3	< 1.3	1.7	< 1.3	**210**	< 1.3	ND	NA
113A	10/16/13		0.8	< 0.5	0.7	0.9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	**8.3**	< 0.5	2.8	< 0.5	< 0.5	< 0.5	**5.2**	< 0.5	**38**	< 0.5	ND	NA
128A	10/16/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**11**	< 0.5	4.4	< 0.5	< 0.5	< 0.5	< 0.5	0.8	**6.8**	< 0.5	ND	NA
136A	10/16/13		< 0.5	< 0.5	2.4	0.9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**90**	< 0.5	6.1	< 0.5	< 0.5	< 0.5	< 0.5	0.8	**62**	**0.6**	ND	NA
139A	12/23/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	ND	NA
141A	12/23/13		< 1.0	< 1.0	< 1.0	< 1.0	27	< 1.0	3.6	< 1.0	8.3	17	< 1.0	2.4	< 1.0	**8.3**	< 1.0	< 4.0	< 1.0	< 1.0	< 1.0	< 1.0	1.0	**27**	**1.6**	ND	NA
142A	12/23/13		< 0.5	< 0.5	< 0.5	0.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**38**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	2.9	1.2	**88**	< 0.5	ND	NA
143A	12/23/13		140	< 100	< 100	< 100	310	970	**340**	< 100	260	**1,200**	< 100	170	< 100	< 100	**9,600**	< 400	**31,000**	< 100	**9,000**	< 100	< 100	< 100	< 100	ND	NA
145A	10/15/13		< 2.5	< 2.5	4	4.8	< 2.5	< 2.5	38	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	**230**	< 2.5	< 10	< 2.5	< 2.5	< 2.5	< 2.5	5.3	**5.3**	**130**	ND	NA
146A	10/17/13		< 0.5	< 0.5	**13**	1.1	< 0.5	1.5	42	< 0.5	0.8	**6.9**	< 0.5	< 0.5	< 0.5	**35**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	3.1	< 0.5	1.3	< 0.5	ND	NA
	10/17/13	DUP-3	< 0.5	< 0.5	**13**	1.1	< 0.5	2.9	**75**	< 0.5	1.5	**13**	< 0.5	< 0.5	< 0.5	**53**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	4.9	< 0.5	1.9	< 0.5	ND	NA
147A	12/23/13		< 1.3	< 1.3	3.8	3.4	< 1.3	1.5	24	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	**210**	< 1.3	< 5.0	< 1.3	< 1.3	< 1.3	3.1	4.2	**54**	14	ND	NA
147A	10/16/13		< 1.0	< 1.0	3.1	2.6	< 1.0	< 1.0	24	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**200**	< 1.0	< 4.0	< 1.0	< 1.0	< 1.0	3.2	3.9	**51**	**15**	ND	NA
	10/16/13	DUP-4	< 1.0	< 1.0	3.4	3.1	< 1.0	< 1.0	25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**180**	< 1.0	< 4.0	< 1.0	< 1.0	< 1.0	3.1	4.5	**51**	**16**	ND	NA
148A	10/16/13		< 1.7	< 1.7	**5.1**	< 1.7	< 1.7	< 1.7	50	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**210**	< 1.7	< 6.7	< 1.7	< 1.7	< 1.7	< 1.7	5.3	3.8	**76**	ND	NA
149A	10/16/13		< 2.5	< 2.5	**5.9**	2.9	< 2.5	< 2.5	12	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	**420**	< 2.5	< 10	< 2.5	< 2.5	< 2.5	< 2.5	**10**	**49**	**39**	ND	NA
150A	10/17/13		< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	**5,100**	**27,000**	**4,700**	**95,000**	< 250	**29,000**	< 250	< 250	**1,700**	**500**	ND	NA
151A	12/23/13		2.6	< 10	**21**	4.4	< 1.0	< 1.0	1.1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**180**	< 1.0	12	< 1.0	< 1.0	< 1.0	4.4	4.8	**25**	**24**	ND	NA
153A	10/15/13		14	< 1.0	**28**	**95**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	14	< 1.0	< 1.0	< 1.0	**6.3**	< 1.0	**5.3**	< 1.0	ND	NA
154A	10/17/13		< 20	< 20	**170**	< 20	< 100	270	**8,000**	< 20	210	**1,200**	< 20	< 20	< 20	**300**	**3,200**	< 80	**11,000**	< 20	**2,600**	**2,600**	< 20	**760**	< 20	ND	NA
	10/17/13	DUP-5	< 50	< 50	**170**	< 50	51	430	**8,000**	< 50	220	**1,300**	< 50	< 50	< 50	**240**	**3,400**	< 200	**11,000**	< 50	**2,500**	**2,800**	< 50	**710**	< 50	ND	NA
155A	10/17/13		1.5	< 0.5	**5.4**	< 0.5	< 0.5	< 0.5	7.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	3.5	0.8	< 2.0	3	< 0.5	3	**84**	< 0.5	2.1	< 0.5	ND	NA
156A	12/23/13		< 0.5	< 0.5	**5.0**	0.7	< 0.5	6.6	**69**	< 0.5	7.6	**14**	< 0.5	11	< 0.5	**66**	< 0.5	< 2.0	0.6	< 0.5	< 0.5	< 0.5	4.7	3.9	130	ND	NA
157A	12/23/13		< 0.5	< 0.5	**6.5**	1.6	< 0.5	21	**88**	< 0.5	11	**24**	< 0.5	12	< 0.5	**76**	< 0.5	< 2.0	0.9	< 0.5	< 0.5	< 0.5	5.0	3.4	320	ND	NA
LF07	10/17/13		1.9	< 0.5	0.7	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.9	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**98**	< 0.5	ND	< 4.0
	10/17/13	DUP-6	1.9	< 0.5	0.7	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.9	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**93**	< 0.5	ND	< 4.0
LF19	10/17/13		1.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**92**	< 0.5	ND	61
LF21	10/17/13		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 4.0
	10/17/13	DUP-7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 4.0
M19A	10/17/13		1.8	< 0.5	1.3	0.8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.4	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**44**	< 0.5	ND	NA
ME43A	10/15/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	6.5	< 0.5	< 0.5	< 0.5	< 0.5	2.8	< 0.5	**98**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	**8.3**	1.9	**38**	**0.8**	ND	NA
MM01A	10/15/13		< 1.0	< 1.0	2.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**130**	< 1.0	< 4.0	< 1.0	< 1.0	< 1.0	1.3	2.3	**9.5**	< 1.0	ND	NA
MM07A	10/16/13		< 2.5	< 2.5	4	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	98	< 2.5	**370**	< 2.5	< 10	< 2.5	< 2.5	< 2.5	**9.9**	3.8	**71**	**8.2**	ND	NA
MM17A	10/17/13		< 1.0	< 1.0	2.5	< 1.0	< 1.0	< 1.0	1.8	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**75**	< 1.0	< 4.0	< 1.0	< 1.0	< 1.0	**34**	1.8	**120**	**2.2**	ND	NA
MM31A	10/17/13		< 1.7	< 1.7	2.4	< 1.7	< 1.7	< 1.7	2.9	< 1.7	< 1.7	< 1.7	< 1.7	2	< 1.7	**100**	< 1.7	< 6.7	< 1.7	< 1.7	< 1.7	**7.2**	1.7	**190**	< 1.7	ND	NA
	10/17/13	DUP-8	< 1.7	< 1.7	2.7	< 1.7	< 1.7	< 1.7	3.1	< 1.7	< 1.7	< 1.7	< 1.7	2	< 1.7	**100**	< 1.7	< 6.7	< 1.7	< 1.7	< 1.7	**7.7**	2	**210**	< 1.7	ND	NA
MM33A	10/17/13		< 0.5	< 0.5	0.8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**32**	< 0.5	3.5	< 0.5	21	< 0.5	< 0.5	< 0.5	2.7	**1.4**	ND	NA
MM34A	10/15/13		0.6	< 0.5	4	1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**92**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	1.4	1.7	**60**	**2.3**	ND	NA
MM37A	10/17/13		< 1.3	< 1.3	2.9	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	**65**	< 1.3	< 5.0	< 1.3	< 1.3	< 1.3	< 1.3	2.3	**220**	< 1.3	ND	NA
MM40A	10/15/13		< 0.5	< 0.5	2	**8.6**	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**89**	< 0.5	4.7	< 0.5	< 0.5	< 0.5	< 0.5	1.2	**19**	**2.5**	ND	NA
MW18AR	10/16/13		< 1.0	< 1.0	2	< 1.0	< 1.0	< 1.0	17	< 1.0	< 1.0	< 1.0	< 1.0	18	< 1.0	**90**	< 1.0	< 4.0	< 1.0	< 1.0	< 1.0	**17**	2.3	**130**	< 1.0	ND	NA
RC4A	12/23/13		< 1.3	< 1.3	**5.2**	5.5	1.9	8.6	42	< 1.3	< 1.3	1.8	< 1.3	< 1.3	< 1.3	**220**	< 1.3	< 5.0	< 1.3	< 1.3	< 1.3	< 1.3	4.0	**6.6**	**58**	ND	NA

Table 1
Groundwater Analytical Results, October 2013
Operable Unit 1
Texas Instruments
Santa Clara, California

Chemical Name			1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2,3-TCB	1,2,4-TCB	1,2-DCB	1,2-DCA	1,3-DCB	1,4-DCB	Carbon Disulfide	Chloro-benzene	Chloroform	cis-1,2-DCE	Ethyl-benzene	Freon 113	m,p-Xylenes	MTBE	O-Xylene	PCE	trans-1,2-DCE	TCE	Vinyl Chloride	All Other VOCs	Perchlorate
	Unit		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Well ID	Sample Date	DUP																									
Cleanup Standard (µg/L)			**200**	--	**5**	**6**	--	--	**60**	--	--	**5**	--	--	**5**	**6**	**68**	**1,200**	**175**[A]	--	**175**[A]	**5**	**10**	**5**	**0.5**	--	--
A/B1-Aquifer Wells																											
17A/B1	10/15/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**28**	< 0.5	ND	NA
45A/B1	10/15/13		< 1.0	< 1.0	1	< 1.0	< 1.0	< 1.0	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**29**	< 1.0	< 4.0	< 1.0	< 1.0	< 1.0	**5.3**	< 1.0	**100**	< 1.0	ND	NA
52A/B1	10/15/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**59**	< 0.5	2.1	< 0.5	< 0.5	< 0.5	**13**	1.6	**57**	< 0.5	ND	NA
71A/B1	10/16/13		14	< 1.3	**6.2**	3.7	< 1.3	< 1.3	2.7	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	**160**	< 1.3	24	< 1.3	< 1.3	< 1.3	1.7	< 1.3	**180**	**7.9**	ND	NA
97A/B1	10/16/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	14	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	ND	NA
98A/B1	10/16/13		6.8	< 1.3	**7.9**	2.8	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	**180**	< 1.3	24	< 1.3	< 1.3	< 1.3	3.5	1.9	**160**	< 1.3	ND	NA
102A/B1	10/16/13		0.6	< 0.5	0.6	0.7	< 0.5	< 0.5	0.8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**19**	< 0.5	2.9	< 0.5	< 0.5	< 0.5	0.5	1.3	**65**	< 0.5	ND	NA
104A/B1	10/16/13		2	< 0.5	3	1.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**41**	< 0.5	3.8	< 0.5	< 0.5	< 0.5	1.3	< 0.5	**67**	< 0.5	ND	NA
105A/B1	10/16/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	ND	NA
106A/B1	10/16/13		2.2	< 0.5	2.6	2.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**45**	< 0.5	4.2	< 0.5	< 0.5	< 0.5	0.6	< 0.5	**150**	< 0.5	ND	< 4.0
108A/B1	10/15/13		1.3	< 0.5	0.6	1.7	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**6.2**	< 0.5	ND	< 4.0
110A/B1	10/15/13		3	< 0.5	1.7	2.1	< 0.5	0.7	3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**44**	< 0.5	14	< 0.5	< 0.5	< 0.5	1.5	< 0.5	**80**	< 0.5	ND	NA
111A/B1	10/17/13		1.9	< 0.5	1	4.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.4	< 0.5	4.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**27**	< 0.5	ND	NA
112A/B1	10/15/13		0.9	< 0.5	0.7	1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5.6	< 0.5	2.1	< 0.5	< 0.5	< 0.5	2.3	< 0.5	**46**	< 0.5	ND	NA
114A/B1	10/16/13		0.7	< 0.5	0.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	3.6	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	**6.6**	< 0.5	**53**	< 0.5	ND	NA
115A/B1	10/15/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**25**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**96**	< 0.5	ND	NA
B1-Aquifer Wells																											
14B1	10/16/13		0.8	< 0.5	0.6	1.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**34**	< 0.5	9.9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**72**	< 0.5	ND	NA
15B1	10/15/13		< 1.0	< 1.0	1.2	< 1.0	< 1.0	< 1.0	1.2	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**91**	< 1.0	< 4.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**110**	< 1.0	ND	NA
	10/15/13	DUP-9	< 1.0	< 1.0	1.2	< 1.0	< 1.0	< 1.0	1.5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**95**	< 1.0	< 4.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**100**	< 1.0	ND	NA
21B1	10/16/13		< 3.1	< 3.1	4.8	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1	**320**	< 3.1	< 13	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1	**65**	**3.7**	ND	NA
72B1	10/16/13		7.6	< 1.7	2.8	3.2	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**180**	< 1.7	38	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**180**	**7.3**	ND	NA
77B1	10/17/13		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**150**	< 1.0	6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**59**	< 1.0	ND	NA
83B1	10/15/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	ND	NA
100B1	10/16/13		< 1.0	< 1.0	1.8	2.1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**150**	< 1.0	21	< 1.0	< 1.0	< 1.0	< 1.0	1	**220**	< 1.0	ND	NA
107B1	10/16/13		1.2	< 0.5	0.7	1.3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.8	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**7.5**	< 0.5	ND	< 4.0
	10/16/13	DUP-10	1.2	< 0.5	0.7	1.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.9	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**7.3**	< 0.5	ND	< 4.0
124B1	10/16/13		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**100**	< 1.0	12	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1	< 1.0	ND	NA
125B1	10/16/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	4.7	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	ND	NA
126B1	10/16/13		1.5	< 1.3	< 1.3	2.8	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	**160**	< 1.3	20	< 1.3	< 1.3	< 1.3	< 1.3	2.2	**120**	< 1.3	ND	NA
127B1	10/16/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**23**	< 0.5	3.3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**9.8**	< 0.5	ND	NA
140B1	10/17/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**20**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	ND	NA
LF02	10/17/13		5	< 0.5	3.2	**6.2**	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**1.1**	**79**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	5.3	**190**	**2.6**	ND	< 4.0
LF06	10/17/13		3.2	< 0.5	2.1	2.8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.3	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**55**	< 0.5	ND	< 4.0
MM14B1	10/16/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.3	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.6	< 0.5	ND	NA
ME07B1	10/17/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**22**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**57**	< 0.5	ND	NA
MM17B1	10/17/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.9	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**1.3**	< 0.5	ND	NA
B2-Aquifer Wells																											
39B2	10/15/13		< 0.5	< 0.5	< 0.5	1.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	2	< 0.5	**3.9**	< 0.5	< 0.5	< 0.5	**5.7**	< 0.5	**78**	< 0.5	ND	NA
71B2	10/16/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**15**	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**10**	< 0.5	ND	NA
ME19B2	10/15/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.9	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.4	< 0.5	ND	NA
MM33B2	10/17/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	4.1	< 0.5	ND	NA
Other Wells																											
HILTONC	10/16/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	ND	NA
Trip Blank Samples																											
TB-1	10/15/13		< 0.5	< 0.5	< 0.5	< 0.5	0.8	3.8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	ND	NA
TB-2	10/16/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	ND	NA
TB-3	10/17/13		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	ND	NA

Notes:
A. Cleanup standard is for total xylenes.
µg/L - micrograms per Liter
VOCs - Volatile Organic Compounds
1,1,1-TCA - 1,1,1-Trichloroethane
1,1,2-TCA - 1,1,2-Trichloroethane
1,1-DCA - 1,1-Dichloroethane
1,1-DCE - 1,1-Dichloroethene
1,2,3-TCB -1,2,3-Trichlorobenzene
1,2,4-TCB - 1,2,4-Trichloro-benzene
1,2-DCB - 1,2-Dichlorobenzene
1,2-DCA - 1,2-Dichloroethane
1,3-DCB - 1,3-Dichlorobenzene
1,4-DCB - 1,4-Dichlorobenzene
cis-1,2-DCE - cis-1,2-Dichloroethene
PCE - Tetrachloroethene
trans-1,2-DCE - trans-1,2-Dichloroethene
Bold - Analytes detected above the laboratory reporting limit and cleanup standard are shown in bold lettering.
ND - Not detected above the laboratory reporting limit
NA - Not Analyzed
TB: - Trip Blank Sample
DUP - Duplicate field Sample

Table 2
Screening Criteria for Comparison of Indoor Air Results
Texas Instruments Incorporated
Santa Clara, California
Project: 750620701

Chemical of Concern	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl Chloride	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,2-DCA	Chloro-ethane	1,1-DCE	Methylene Chloride	Chloroform	1,2,3-TCB	1,2,4-TCB	1,2-DCB	1,3-DCB	1,4-DCB	Chloro-benzene	Toluene	Ethyl-benzene	Total Xylenes	Trichloro-fluro-methane	Freon 113
Laboratory Reporting Limit	0.17	0.13	0.099	0.099	0.026	0.14	0.14	0.10	0.10	0.066	0.099	0.087	0.12	0.19	0.19	0.15	0.15	0.15	0.12	0.19	0.11	0.11	0.14	0.19
Background / Outdoor Ambient																								
Background (Outdoor Ambient)	(to be determined)																							
Short-Term Health Based Screening Criteria[1]																								
Acute Exposure MRL[2]	1,357	NE	810	810	1,278	10,914	NE	NE	NE	39,583	NE	NE	488	NE	NE	NE	NE	12,025	NE	3,768	21,710	8,685	NE	NE
Intermediate Exposure MRL[3]	NE	NE	810	810	77	3,820	NE	NE	NE	NE	79	NE	244	NE	NE	NE	NE	1,203	NE	NE	8,684	2,605	NE	NE
USEPA Regional Screening Levels[4]																								
Residential Screening Level[5]	9.4	0.43	NE	63	0.16	5,200	0.15	1.5	0.094	10,000	210	96	0.11	NE	2.1	210	NE	0.22	52	5,200	0.97	100	730	31,000
Industrial/Commercial Screening Level[6]	47	3	NE	260	2.8	22,000	0.77	7.7	0.47	44,000	880	1,200	0.53	NE	8.8	880	NE	1.1	220	22,000	4.9	440	3,100	130,000
RWQCB Environmental Screening Level[7]																								
Residential	0.41	0.59	7.3	63	0.031	5,200	0.15	1.5	0.12	31,000	210	5.2	0.46	NE	4.2	210	NE	0.22	1,000	310	0.97	100	NE	NE
Commercial or Industrial	2.1	3.0	31	260	0.16	22,000	0.77	7.7	0.58	130,000	880	26	2.3	NE	18	880	NE	1.1	4,400	1,300	4.9	440	NE	NE

Notes:
Units in micrograms per cubic meter ($\mu g/m^3$) at 25° Celsius and 1 atmosphere.

PCE - tetrachloroethene
TCE - trichloroethene
cis-1,2-DCE - cis-1,2-dichloroethene
trans-1,2-DCE - trans-1,2-dichloroethene
1,1,1-TCA - 1,1,1-trichloroethane
1,1,2-TCA - 1,1,2-trichloroethane
1,1-DCA - 1,1-dichloroethane
1,2-DCA - 1,2-dichloroethane
1,1-DCE - 1,1-dichloroethene
chloroethane - ethyl chloride
Methylene Choride - Dichloromethane
1,2,3-TCB - 1,2,3-trichlorobenzene
1,2,4-TCB - 1,2,4-trichlorobenzene
1,2-DCB - 1,2-dichlorobenzene
1,3-DCB - 1,3-dichlorobenzene
1,4-DCB - 1,4-dichlorobenzene
Freon 11 - trichlorofluoromethane
Freon 113 - trichlorotrifluoroethane
NE - Not established
RSL - Regional Screening Level
ESL - Environmental Screening Level

[1] - Short-term health risk based screening criteria obtained from the Agency for Toxic Substances & Disease Registry (ATSDR), Minimal Risk Levels (MRLs) for hazardous substances (July 2013) available at http://www.atsdr.cdc.gov/mrls/index.html)
[2] - Acute screening levels (Acute MRLs) are derived for exposure durations of 1 to 14 days.
[3] - Intermediate MRLs are derived for exposure durations of >14 to 364 days
[4] - Long-term health risk based screening criteria obtained from the United States Environmental Protection Agency (USEPA), Regional Screening (RSLs) for chemical contaminants, THQ = 1.0 (November 2013).
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/docs/master_sl_table_run_NOV2013.pdf
[5] - Residential screening levels (Residential Air RSLs) are derived for exposure durations of 350 days per year and 30 years.
[6] - Commercial/Industrial screening levels (Industrial Air RSLs) are derived for exposure durations of 8 hours per day, 250 days per year and 25 years.
[7] - Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) indoor air from Table E-3, December 2013.
USEPA recommends the use of Interim TCE Indoor Air Short-Term Response Action Levels for TCE Inhalation exposure from subsurface vapor intrusion at South Bay National Priority List Sites. Commercial/Industrial prompt response action levels are calculated as the time-weighted average from the RfC - 9 $\mu g/m^3$ for an 8-hour workday; 7 $\mu g/m^3$ for a 10-hour workday. Based on input from commercial building owners and tenants, EPA Region 9 recommends use of the 10-hour workday for determining the appropriate response action levels for Commercial/Industrial buildings at the South Bay Sites. Time-weighted adjustments can be made as needed for workplaces with longer work schedules.

Table 3
Historical Soil Gas and Air Monitoring Results - 2004 to 2010
Texas Instruments Incorporated
Santa Clara, California
Project: 750620701

Building	Sample ID	Sample Type	Sample Date	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2,4-Trimethylbenzene	1,2-Dichlorobenzene	cis-1,2-Dichloroethene	2-Butanone	Acetone	Benzene	Ethylbenzene	Freon 113	o-Xylene	m,p-Xylenes	Total Xylenes	PCE	Toluene	TCE	All Other Analytes
RWQCB Environmental Screening Level				µg/m³																	
Indoor Air (Commercial)				**22,000**	**7.7**	**880**	**NA**	**880**	**31**	**22,000**	**31,000**	**0.42**	**4.9**	**NA**	**NA**	**NA**	**440**	**2.1**	**1,300**	**3**	**--**
Soil Gas (Commercial)				**22,000,000**	**7,700**	**880,000**	**NA**	**880,000**	**31,000**	**16,000,000**	**15,000,000**	**420**	**4,900**	**NA**	**NA**	**NA**	**220,000**	**2,100**	**1,300,000**	**3,000**	**--**
2004																					
19	A-4	Ambient Air	05/06/04	< 0.97 U	< 0.72 U	< 0.7 U	< 0.87 U	1.5	< 0.7 U	< 2.6 U	6.1	0.95	< 0.77 U	< 1.4 U	< 0.77 U	1.3	--	< 1.2 U	2.7	< 0.96 U	ND
19	IA-4	Indoor Air	05/06/04	< 0.91 U	< 0.67 U	< 0.66 U	< 0.82 U	< 1 U	< 0.66 U	< 2.4 U	8.4	1.5	< 0.72 U	< 1.3 U	< 0.72 U	1.2	--	< 1.1 U	3.3	< 0.9 U	ND
19	SG-4	Soil Gas	05/06/04	3,900	< 55 U	320	< 67 U	< 82 U	< 54 U	< 200 U	< 160 U	< 44 U	< 59 U	2,200	< 59 U	< 59 U	--	560	< 51 U	12,000	ND
19	SG-4 dup	Soil Gas	05/06/04	3,900	< 57 U	300	< 69 U	< 85 U	< 56 U	< 210 U	< 170 U	< 45 U	< 61 U	2,200	< 61 U	< 61 U	--	560	< 53 U	12,000	ND
19	SG-8	Soil Gas	05/06/04	87	< 22 U	< 22 U	< 27 U	< 33 U	< 22 U	< 82 U	110	< 18 U	< 24 U	73	< 24 U	< 24 U	--	550	< 21 U	4,000	ND
39	A-6	Ambient Air	05/06/04	< 0.99 U	< 0.74 U	< 0.72 U	< 0.89 U	< 1.1 U	< 0.72 U	< 2.7 U	7.1	0.98	< 0.79 U	< 1.4 U	< 0.79 U	1.1	--	< 1.2 U	2.3	< 0.98 U	ND
39	IA-6	Indoor Air	05/06/04	< 0.95 U	< 0.7 U	< 0.69 U	1.1	< 1 U	< 0.69 U	< 2.6 U	17	1.3	< 0.75 U	< 1.3 U	0.72 J	2	--	< 1.2 U	3.9	< 0.93 U	ND
39	SG-6	Soil Gas	05/06/04	120	110	< 29 U	< 36 U	< 44 U	180	< 110U	< 87	< 23	< 32 U	1,600	< 32 U	< 32 U	--	110	< 28 U	7,800	ND
E	A-2	Ambient Air	05/06/04	< 1.1 U	< 0.81 U	< 0.79 U	< 0.98 U	< 1.2 U	< 0.79 U	< 2.9 U	6.8	0.85	< 0.86 U	< 1.5 U	< 0.86 U	1.2	--	< 1.4 U	2.1	< 1.1 U	ND
E	IA-2	Indoor Air	05/06/04	< 1 U	< 0.78 U	< 0.77 U	< 0.95 U	< 1.2 U	< 0.77 U	< 2.9 U	12	1.1	1	< 1.5 U	0.87	2.5	--	< 1.3 U	13	< 1 U	ND
E	SG-2	Soil Gas	05/06/04	110	< 11 U	14	< 13 U	< 16 U	< 11 U	< 40 U	46	< 8.7	< 12 U	120	< 12 U	< 12 U	--	680	12	2,400	ND
2006																					
C	A-1	Indoor	09/28/06	< 1.1 U	< 0.81 U	< 0.79 U	< 2.0 U	< 1.2 U	< 0.79 U	3.2	29	0.8	< 0.87	2.4	--	--	< 2.2 U	0.26	3.1	< 1.1	ND
C	A-3	Indoor	09/28/06	< 1.1 U	< 0.81 U	< 0.79 U	< 2.0 U	< 1.2 U	< 0.79 U	4.4	30	0.91	< 0.87	2.8	--	--	< 2.2 U	0.76	3.6	< 1.1	ND
C	A-2	Outdoor	09/28/06	0.18	< 0.81 U	< 0.79 U	< 2.0 U	< 1.2 U	< 0.79 U	4	19	0.92	< 0.87	2.7	--	--	< 2.2 U	0.22	3.1	< 1.1	ND
2007																					
C	IA-AL3	Indoor	09/13/07	< 1.1 U	<0.11 U	<0.053 U	<0.66 U	<0.80 U	<0.11 U	--	--	--	0.52	--	--	--	2.13	0.6	--	<0.14	ND
C	IA-D4	Indoor	09/13/07	0.24	<0.14 U	<0.069 U	<0.86 U	<1.0 U	<0.14 U	--	--	--	0.2	--	--	--	0.65	0.28	--	<0.19	ND
C	IA-F4	Indoor	09/13/07	<0.19 U	<0.13 U	<0.063 U	<0.78 U	<0.95 U	<0.12 U	--	--	--	0.82	--	--	--	2.14	0.21	--	<0.17	ND
C	HVAC-1	Outdoor	09/13/07	<0.19 U	<0.14 U	<0.068 U	<0.84 U	<1.0 U	<0.14 U	--	--	--	0.16	--	--	--	0.4	<0.23	--	<0.18	ND
C	HVAC-2	Outdoor	09/13/07	<0.20 U	<0.15 U	<0.072 U	<0.90 U	<1.1 U	<0.14 U	--	--	--	<0.16	--	--	--	0.38	<0.25	--	<0.20	ND
2010																					
C	A-Front Entry Area	Indoor Air	01/04/10	<9.6	<7.1	<7.0	580	<10	<7	29	130	1,600	120	--	<7.6	<7.6	1,720	<12	1,500	<9.4	ND
C	B-COL.E6	Indoor Air	01/04/10	<4.8	<3.6	<3.5	<4.3	6	<3.5	<2.6	<8.4	<2.8	<4.3	--	<3.8	<3.8	<3.8	<6.0	3.7	<4.7	ND
C	C-2nd Floor Stair (NW)	Indoor Air	01/04/10	<4.9	<3.7	<3.6	<4.4	16	<3.6	<2.7	11	<2.9	<4.4	--	<3.9	<3.9	<3.9	<6.1	<3.4	<4.9	ND

Notes:
< = Compound analyzed for but not detected above the reporting limit
RWQCB = Regional Water Quality Control Board
ESL = Environmental Screening Level (San Francisco Bay Regional Water Quality Control Board, December 2013 - Table E-3, Indoor Air Screening Levels)
J = Estimated value
NA = ESL value not available
NC = Chemical Not Considered a Carcinogen
ND = Chemical Not Detected
PCE = Perchloroethene/Tetrachloroethene
TCE = Trichloroethene
U = Compound analyzed for but not detected above the reporting limit
µg/m3 = Micrograms per cubic meter
-- = not available
Red = exceeds RWQCB Commercial/Industrial ESL for indoor air or soil gas

Table 4
Indoor, Pathway and Ambient Air Analytical Results - December 2012 to April 2013
Buildings 9, 19, 39, C, E, F, and G
Texas Instruments Incorporated
Santa Clara, California
Project: 750620701

Chemical of Concern	Sample Date	Vinyl Chloride	Chloro-ethane	Trichloro-fluro-methane	1,1-DCE	Methylene Chloride	1,1-DCA	cis-1,2-DCE	Chloroform	1,2-DCA	1,1,1-TCA	Chloro-benzene	1,2-DCB	1,4-DCB	1,1,2-TCA	Toluene	TCE	PCE	Ethyl-benzene	Total Xylenes	trans-1,2-DCE	Freon 113
Unit		($\mu g/m^3$)																				
Building 9 with HVAC																						
IA1-9-2012-12-13	12/13/12	< 0.031	< 0.27	1.2	< 0.02	0.47	< 0.41	< 0.4	0.23	0.12	< 0.55	< 0.47	< 0.61	0.066	< 0.098	1.4	0.13	0.1	0.3	1.4	< 0.4	< 0.78
IA2-9-2012-12-13	12/13/12	< 0.031	< 0.27	1.6	< 0.02	0.57	< 0.41	< 0.4	0.26	0.18	< 0.55	< 0.47	< 0.61	0.077	< 0.098	1.6	0.59	0.54	0.36	1.6	< 0.4	< 0.78
IA3-9-2012-12-13	12/13/12	< 0.031	< 0.27	1.4	< 0.02	0.45	< 0.41	< 0.4	0.16	0.094	< 0.55	< 0.47	< 0.61	0.052	< 0.098	1.3	0.12	0.069	0.28	1.3	< 0.4	< 0.78
IA4-9-2012-12-13	12/13/12	< 0.031	< 0.27	1.4	< 0.02	0.67	< 0.41	< 0.4	0.11	0.13	< 0.55	< 0.47	< 0.61	0.052	< 0.098	1.2	0.096	0.084	0.26	1.2	< 0.4	< 0.78
Building 9 without HVAC																						
IA1-9-2012-12-30	12/30/12	< 0.031	< 0.27	1.5	< 0.02	0.38	< 0.41	< 0.4	0.37	0.39	< 0.55	< 0.47	< 0.61	0.071	< 0.098	1.6	1.7	0.46	0.33	1.5	< 0.4	< 0.78
IA2-9-2012-12-30	12/30/12	< 0.031	< 0.27	1.4	< 0.02	0.43	< 0.41	< 0.4	0.21	0.085	< 0.55	< 0.47	< 0.61	0.074	< 0.098	1.1	0.27	0.14	0.22	1.0	< 0.4	< 0.78
IA3-9-2012-12-30	12/30/12	< 0.031	< 0.27	1.8	< 0.02	0.49	< 0.41	< 0.4	0.29	0.43	< 0.55	< 0.47	< 0.61	0.079	< 0.098	2.3	1.8	0.58	0.43	1.9	< 0.4	< 0.78
IA4-9-2012-12-30	12/30/12	< 0.031	< 0.27	1.4	< 0.02	0.37	< 0.41	< 0.4	0.20	**0.66**	< 0.55	< 0.47	< 0.61	0.065	< 0.098	1.7	1.7	0.42	0.36	1.6	< 0.4	< 0.78
Building 19 with HVAC																						
IA1-19-2012-12-13	12/13/12	< 0.031	< 0.27	1.5	< 0.02	0.84	< 0.41	< 0.4	0.18	0.078	< 0.55	< 0.47	< 0.61	0.088	< 0.098	9.1	0.91	0.14	2.0	11	< 0.4	< 0.78
IA2-19-2012-12-13	12/13/12	< 0.031	< 0.27	1.8	< 0.02	0.9	< 0.41	< 0.4	0.24	0.079	< 0.55	< 0.47	< 0.61	0.085	< 0.098	8.1	0.98	0.15	1.8	9.3	< 0.4	< 0.78
IA3-19-2012-12-13	12/13/12	< 0.031	< 0.27	1.7	< 0.02	0.87	< 0.41	< 0.4	0.16	0.081	< 0.55	< 0.47	< 0.61	0.080	< 0.098	11	0.94	0.15	2.4	13	< 0.4	< 0.78
PS1-19-2012-12-13	12/13/12	< 0.031	< 0.27	1.2	< 0.02	0.93	< 0.41	< 0.4	0.17	0.088	< 0.55	< 0.47	< 0.61	0.085	< 0.098	12	1.2	0.16	2.6	13	< 0.4	< 0.78
Building 19 without HVAC																						
IA1-19-2012-12-30	12/30/12	< 0.031	< 0.27	1.8	< 0.02	1.2	< 0.41	< 0.4	0.21	0.11	< 0.55	< 0.47	< 0.61	0.082	< 0.098	10	2.1	0.31	2.0	10	< 0.4	0.88
IA2-19-2012-12-30	12/30/12	< 0.031	< 0.27	1.7	0.039	1.2	< 0.41	< 0.4	0.16	0.099	< 0.55	< 0.47	< 0.61	0.090	< 0.098	9.3	1.3	0.22	1.8	8.9	< 0.4	0.86
IA3-19-2012-12-30	12/30/12	< 0.031	< 0.27	1.7	0.050	1.9	< 0.41	< 0.4	0.17	0.11	1.2	< 0.47	< 0.61	0.095	< 0.098	16	1.8	0.21	3.1	16	< 0.4	0.97
PS1-19-2012-12-30	12/30/12	< 0.031	< 0.27	1.7	0.056	1.2	< 0.41	< 0.4	0.23	0.11	0.56	< 0.47	< 0.61	0.092	< 0.098	10	1.9	0.29	2.0	10	< 0.4	0.92
Building 39 with HVAC																						
IA1-39-2012-12-18	12/18/12	< 0.031	< 0.27	1.3	< 0.02	0.47	< 0.41	< 0.4	0.12	0.080	< 0.55	< 0.47	< 0.61	0.14	< 0.098	1.5	0.31	0.081	0.31	1.4	< 0.4	< 0.78
IA2-39-2012-12-18	12/18/12	< 0.031	< 0.27	1.6	< 0.02	1.0	< 0.41	< 0.4	0.13	0.080	< 0.55	< 0.47	< 0.61	0.062	< 0.098	1.3	0.21	0.079	0.27	1.2	< 0.4	< 0.78
DUP2-2012-12-18	12/18/12	< 0.031	< 0.27	1.6	< 0.02	0.5	< 0.41	< 0.4	0.12	0.078	< 0.55	< 0.47	< 0.61	0.061	< 0.098	1.3	0.22	0.078	0.28	1.3	< 0.4	< 0.78
IA3-39-2012-12-18	12/18/12	< 0.031	< 0.27	1.6	< 0.02	0.42	< 0.41	< 0.4	0.17	0.075	< 0.55	< 0.47	< 0.61	0.083	< 0.098	1.2	0.22	0.086	0.26	1.2	< 0.4	< 0.78
PS1-39-2012-12-18	12/18/12	< 0.031	< 0.27	1.5	< 0.02	0.96	< 0.41	< 0.4	0.28	0.076	< 0.55	< 0.47	< 0.61	0.091	< 0.098	1.4	2.4	0.47	0.30	1.3	< 0.4	1.9
Building 39 without HVAC																						
IA1-39-2013-01-06	01/06/13	< 0.031	< 0.27	1.8	0.053	0.43	< 0.41	< 0.4	0.16	0.130	< 0.55	< 0.47	< 0.61	0.12	< 0.098	1.4	0.96	0.44	0.37	1.6	< 0.4	2.7
IA2-39-2013-01-06	01/06/13	< 0.031	< 0.27	1.7	0.025	0.39	< 0.41	< 0.4	0.16	0.10	< 0.55	< 0.47	< 0.61	0.10	< 0.098	1.2	0.56	0.16	0.29	1.3	< 0.4	1.9
DUP2-2013-01-06	01/06/13	< 0.031	< 0.27	1.7	0.023	0.64	< 0.41	< 0.4	0.20	0.097	< 0.55	< 0.47	< 0.61	0.10	< 0.098	1.2	0.56	0.15	0.29	1.3	< 0.4	1.9
IA3-39-2013-01-06	01/06/13	< 0.031	< 0.27	1.8	< 0.02	0.43	< 0.41	< 0.4	0.18	0.10	< 0.55	< 0.47	< 0.61	0.093	< 0.098	1.4	0.67	0.18	0.29	1.3	< 0.4	2.4
PS1-39-2013-01-06	01/06/13	< 0.031	< 0.27	2.5	0.48	0.39	0.60	2.0	**3.5**	0.074	5.3	< 0.47	< 0.61	0.11	< 0.098	1.2	**27**	**6.2**	0.25	1.1	< 0.4	37
PS1-39-2013-04-28	04/28/13	< 0.026	< 0.053	1.3	0.078	< 0.69	0.21	0.3	**1.6**	0.060	1.7	< 0.092	< 0.12	< 0.12	< 0.11	0.87	**16**	**3.2**	0.14	0.53	< 0.40	7.5
PS2-39-2013-04-28	04/28/13	< 0.026	< 0.053	1.4	< 0.040	< 0.69	< 0.081	< 0.079	0.12	0.072	0.39	< 0.092	< 0.12	< 0.12	< 0.11	0.86	**13**	0.79	0.14	0.54	< 0.40	2.7
Building C with HVAC																						
IA1-C-2013-01-18	01/18/13	< 0.026	< 0.053	1.2	< 0.040	1.1	< 0.081	< 0.079	0.25	0.080	< 0.11	< 0.092	< 0.12	0.23	< 0.11	4.9	0.17	0.44	0.84	3.9	< 0.40	0.48
IA2-C-2013-01-18	01/18/13	< 0.026	< 0.053	1.1	< 0.040	0.93	< 0.081	< 0.079	0.21	0.074	< 0.11	< 0.092	< 0.12	0.21	< 0.11	3.9	0.13	0.31	0.69	3.34	< 0.40	0.47
IA3-C-2013-01-18	01/18/13	< 0.026	0.053	1.0	< 0.040	0.78	< 0.081	< 0.079	0.19	0.07	< 0.11	< 0.092	< 0.12	0.2	< 0.11	3.5	0.12	0.22	0.60	2.94	< 0.40	0.45
IA4-C-2013-01-18	01/18/13	< 0.026	< 0.053	1.4	< 0.040	1.2	< 0.081	< 0.079	0.32	0.12	0.13	< 0.092	< 0.12	0.32	< 0.11	5.7	0.22	0.86	1.0	5.1	< 0.40	0.59
IA5-C-2013-01-18	01/18/13	< 0.026	< 0.053	1.1	< 0.040	0.89	< 0.081	< 0.079	0.21	0.11	0.11	< 0.092	< 0.12	0.22	< 0.11	4.2	0.14	1.1	0.99	3.8	< 0.40	0.48
IA6-C-2013-01-18	01/18/13	< 0.026	< 0.053	1.1	< 0.040	0.86	< 0.081	< 0.079	0.22	0.081	0.22	< 0.092	< 0.12	0.23	< 0.11	4.3	0.16	1.8	0.74	3.5	< 0.40	0.50
DUP4-C-2013-01-18	01/18/13	< 0.026	< 0.053	1.1	< 0.040	1.5	< 0.081	< 0.079	0.24	0.077	0.18	< 0.092	< 0.12	0.16	< 0.11	4.4	0.16	1.5	0.85	3.8	< 0.40	0.49
IA7-C-2013-01-18	01/18/13	< 0.026	< 0.053	1.1	< 0.040	0.97	< 0.081	< 0.079	0.21	0.084	< 0.11	< 0.092	< 0.12	0.26	< 0.11	4.5	0.14	0.23	0.71	3.33	< 0.40	0.48
PS1-C-2013-01-18	01/18/13	< 0.026	< 0.053	1.1	< 0.040	0.86	< 0.081	< 0.079	0.26	0.076	0.13	< 0.092	< 0.12	0.18	0.13	4.3	0.15	1.3	0.75	3.5	< 0.40	0.50
PS2-C-2013-01-18	01/18/13	< 0.026	< 0.053	1.1	< 0.040	1.0	< 0.081	0.12	0.24	0.083	0.14	< 0.092	< 0.12	0.29	0.14	4.3	0.34	1.2	0.75	3.6	< 0.40	0.50

Table 4
Indoor, Pathway and Ambient Air Analytical Results - December 2012 to April 2013
Buildings 9, 19, 39, C, E, F, and G
Texas Instruments Incorporated
Santa Clara, California
Project: 750620701

Chemical of Concern	Sample Date	Vinyl Chloride	Chloro-ethane	Trichloro-fluro-methane	1,1-DCE	Methylene Chloride	1,1-DCA	cis-1,2-DCE	Chloroform	1,2-DCA	1,1,1-TCA	Chloro-benzene	1,2-DCB	1,4-DCB	1,1,2-TCA	Toluene	TCE	PCE	Ethyl-benzene	Total Xylenes	trans-1,2-DCE	Freon 113
Unit		**($\mu g/m^3$)**																				
Building C without HVAC																						
IA1-C-2013-01-20	01/20/13	< 0.026	< 0.053	2.1	< 0.040	2.5	< 0.081	< 0.079	0.34	0.11	0.28	< 0.092	< 0.12	0.33	< 0.11	7.1	0.19	**2.7**	1.1	4.7	4.7	0.72
IA2-C-2013-01-20	01/20/13	< 0.026	< 0.053	1.7	< 0.040	1.3	< 0.081	< 0.079	0.34	0.12	0.22	< 0.092	< 0.12	0.31	< 0.11	4.9	0.17	1.7	0.94	3.5	1.0	0.68
IA3-C-2013-01-20	01/20/13	< 0.026	< 0.053	1.7	< 0.040	1.3	< 0.081	< 0.079	0.33	0.14	0.23	< 0.092	< 0.12	0.28	< 0.11	5.0	0.17	1.7	0.89	3.6	1.1	0.65
IA4-C-2013-01-20	01/20/13	< 0.026	< 0.053	1.9	< 0.040	1.1	< 0.081	< 0.079	0.5	0.19	0.16	< 0.092	< 0.12	0.4	< 0.11	5.0	0.16	0.83	0.86	3.8	< 0.40	0.85
IA5-C-2013-01-20	01/20/13	< 0.026	< 0.053	1.4	0.041	1.2	< 0.081	0.41	0.39	0.14	1.2	< 0.092	< 0.12	0.31	< 0.11	4.7	0.29	**12**	0.84	3.5	< 0.40	0.76
IA6-C-2013-01-20	01/20/13	< 0.026	< 0.053	1.4	0.054	1.2	0.11	0.63	0.41	0.15	1.9	< 0.092	< 0.12	0.27	< 0.11	4.8	0.37	**18**	0.86	3.6	< 0.40	0.83
DUP4-2013-01-20	01/20/13	< 0.026	< 0.053	1.4	0.05	1.2	0.10	0.57	0.41	0.14	1.8	< 0.092	< 0.12	0.29	< 0.11	4.4	0.33	**16**	0.78	3.24	< 0.40	0.80
IA7-C-2013-01-20	01/20/13	< 0.026	< 0.053	1.5	< 0.04	2.5	< 0.081	0.22	0.4	0.16	0.63	< 0.092	< 0.12	0.21	< 0.11	5.3	0.26	**5.0**	0.77	3.08	0.9	0.68
PS1-C-2013-01-20	01/20/13	< 0.026	< 0.053	1.4	< 0.04	1.2	< 0.081	0.2	0.35	0.13	0.9	< 0.092	< 0.12	0.28	< 0.11	5.0	0.2	**9.8**	0.88	3.9	< 0.40	0.71
PS2-C-2013-01-20	01/20/13	< 0.026	< 0.053	1.5	0.053	1.7	0.12	0.75	0.42	0.16	1.8	< 0.092	< 0.12	0.28	< 0.11	4.9	0.4	**17**	1.0	4.0	< 0.40	0.82
Building E with HVAC																						
IA1-E-2013-01-18	01/18/13	< 0.026	< 0.053	1.3	< 0.040	< 0.69	< 0.081	< 0.079	0.22	0.088	< 0.11	< 0.092	< 0.12	0.2	< 0.11	4.0	0.3	< 0.14	0.67	3.34	< 0.40	0.53
DUP3-E-2013-01-18	01/18/13	< 0.026	< 0.053	1.3	< 0.040	< 0.69	< 0.081	< 0.079	0.22	0.085	< 0.11	< 0.092	< 0.12	0.18	< 0.11	3.9	0.31	< 0.14	0.68	3.2	< 0.40	0.53
IA2-E-2013-01-18	01/18/13	< 0.026	< 0.053	1.4	< 0.040	< 0.69	< 0.081	< 0.079	0.24	0.091	< 0.11	< 0.092	< 0.12	0.2	< 0.11	4.0	0.35	< 0.14	0.67	3.19	< 0.40	0.62
IA3-E-2013-01-18	01/18/13	< 0.026	< 0.053	1.6	< 0.040	< 0.69	< 0.081	< 0.079	0.24	0.089	< 0.11	< 0.092	< 0.12	0.13	< 0.11	3.2	0.2	< 0.14	0.5	2.49	< 0.40	0.67
IA4-E-2013-01-18	01/18/13	< 0.26	< 0.053	1.5	< 0.40	< 0.69	< 0.081	< 0.079	0.27	0.12	< 0.11	< 0.092	< 0.12	0.16	< 0.11	4.3	0.19	< 0.14	0.62	3.21	< 0.40	0.61
IA5-E-2013-01-18	01/18/13	< 0.026	< 0.053	1.2	< 0.040	< 0.69	< 0.081	< 0.079	0.2	0.075	< 0.11	< 0.092	< 0.12	< 0.12	< 0.11	3.6	0.19	< 0.14	0.58	2.8	< 0.40	0.51
IA6-E-2013-01-18	01/18/13	< 0.026	< 0.053	1.3	< 0.040	< 0.69	< 0.081	< 0.079	0.21	0.076	< 0.11	< 0.092	< 0.12	0.14	< 0.11	3.6	0.25	< 0.14	0.62	3.04	< 0.40	0.51
PS1-E-2013-01-18	01/18/13	< 0.026	< 0.053	1.2	< 0.040	< 0.69	< 0.081	< 0.079	0.21	0.076	< 0.11	< 0.092	< 0.12	0.14	< 0.11	3.7	0.25	< 0.14	0.68	3.19	< 0.40	0.48
PS2-E-2013-01-18	01/18/13	< 0.026	< 0.053	1.2	< 0.040	1.8	< 0.081	< 0.079	0.18	0.079	< 0.11	< 0.092	< 0.12	0.12	< 0.11	3.6	0.23	0.22	0.6	2.83	< 0.40	0.5
PS3-E-2013-01-18	01/18/13	< 0.026	< 0.053	1.1	< 0.040	0.82	< 0.081	< 0.079	0.14	0.064	< 0.11	< 0.092	< 0.12	0.13	< 0.11	8.9	0.16	0.15	0.79	3.15	< 0.40	0.47
PS4-E-2013-01-18	01/18/13	< 0.026	< 0.053	1.6	0.059	0.7	0.08	0.96	0.27	0.078	0.51	< 0.092	< 0.12	0.13	< 0.11	3.7	**16**	1.6	0.89	3.9	< 0.40	3.3
Building E without HVAC																						
1A1-E-2013-01-20	01/20/13	< 0.026	< 0.053	2.2	< 0.040	0.81	< 0.081	< 0.079	0.3	0.13	0.12	< 0.092	< 0.12	0.2	< 0.11	3.0	0.36	0.14	0.54	2.24	< 0.40	0.71
DUP3-E-2013-01-20	01/20/13	< 0.026	< 0.053	2.2	< 0.040	0.79	< 0.081	< 0.079	0.3	0.13	0.12	< 0.092	< 0.12	0.18	< 0.11	2.9	0.35	0.14	0.53	2.1	< 0.40	0.71
IA2-E-2013-01-20	01/20/13	< 0.026	< 0.053	2.2	< 0.040	0.78	< 0.081	< 0.079	0.26	0.10	< 0.11	< 0.092	< 0.12	0.17	< 0.11	2.7	0.3	< 0.14	0.45	2.04	< 0.40	0.68
1A3-E-2013-01-20	01/20/13	< 0.026	< 0.053	2.2	< 0.040	< 0.69	< 0.081	< 0.079	0.22	0.086	< 0.11	< 0.092	< 0.12	0.13	< 0.11	1.7	0.12	< 0.14	0.24	1.02	< 0.40	0.64
1A4-E-2013-01-20	01/20/13	< 0.026	0.093	2.5	< 0.040	0.79	< 0.081	< 0.079	0.31	0.11	< 0.11	< 0.092	< 0.12	0.19	< 0.11	3.2	0.14	< 0.14	0.53	2.82	< 0.40	0.69
1A5-E-2013-01-20	01/20/13	< 0.026	< 0.053	2.1	< 0.40	1.0	< 0.081	< 0.079	0.29	0.11	< 0.11	< 0.092	< 0.12	0.2	< 0.11	3.3	0.22	0.15	0.58	2.56	< 0.40	0.63
1A6-E-2013-01-20	01/20/13	< 0.026	< 0.053	1.8	< 0.040	0.7	< 0.081	< 0.079	0.32	0.11	0.15	< 0.092	< 0.12	0.28	< 0.11	3.1	0.3	0.21	0.53	2.38	< 0.40	0.68
PS1-E-2013-01-20	01/20/13	< 0.026	< 0.053	1.9	< 0.040	0.75	< 0.081	< 0.079	0.32	0.17	0.14	0.21	1.3	**1.8**	0.18	3.3	0.42	0.2	0.62	2.78	< 0.40	0.68
PS2-E-2013-01-20	01/20/13	0.031	< 0.053	1.8	< 0.040	< 0.69	< 0.081	0.16	0.26	0.098	< 0.11	< 0.092	< 0.12	0.22	< 0.11	2.9	0.57	0.25	0.48	2.23	< 0.40	0.64
PS3-E-2013-01-20	01/20/13	< 0.026	< 0.053	2.1	< 0.040	0.87	< 0.081	< 0.079	0.34	0.11	< 0.11	< 0.092	< 0.12	0.32	< 0.11	3.3	0.36	0.33	0.57	2.52	< 0.40	0.66
PS4-E-2013-01-20	01/20/13	< 0.026	< 0.053	2.2	0.1	< 0.69	0.11	1.0	0.3	0.11	0.53	< 0.092	< 0.12	0.2	< 0.11	2.3	**18**	1.8	0.74	2.71	< 0.40	3.6
Building F with HVAC																						
IA1-F-2013-01-18	01/18/13	< 0.026	< 0.053	3.9	< 0.040	< 0.69	< 0.081	< 0.079	0.51	0.067	< 0.11	< 0.092	< 0.12	< 0.12	< 0.11	3.1	0.27	< 0.14	0.49	2.19	< 0.40	0.51
IA2-F-2013-01-18	01/18/13	< 0.026	< 0.053	1.7	< 0.040	< 0.69	< 0.081	< 0.079	0.15	0.061	< 0.11	< 0.092	< 0.12	< 0.12	< 0.11	2.4	0.11	< 0.14	0.39	1.92	< 0.40	0.47
Building F without HVAC																						
1A1-F-2013-01-20	01/20/13	< 0.026	< 0.053	5.9	< 0.040	< 0.69	< 0.081	< 0.079	0.47	0.081	< 0.11	< 0.092	< 0.12	0.19	< 0.11	2.6	0.31	0.17	0.47	1.83	< 0.40	0.67
1A2-F-2013-01-20	01/20/13	< 0.026	< 0.053	48	< 0.040	< 0.69	< 0.081	< 0.079	0.3	0.097	< 0.11	< 0.092	< 0.12	0.24	< 0.11	4.1	0.31	0.16	0.73	2.62	< 0.40	0.67
Building G with HVAC																						
IA1-G-2012-12-13	12/13/12	< 0.031	< 0.27	0.68	< 0.02	0.43	< 0.41	< 0.4	0.11	0.064	< 0.55	< 0.47	< 0.61	0.041	< 0.098	1.0	0.13	0.059	0.22	1.0	< 0.4	< 0.78
DUP1-2012-12-13	12/13/12	< 0.031	< 0.27	1.1	< 0.02	0.43	< 0.41	< 0.4	0.12	0.072	< 0.55	< 0.47	< 0.61	0.038	< 0.098	0.95	0.11	0.12	0.21	0.94	< 0.4	< 0.78
IA2-G-2012-12-13	12/13/12	< 0.031	< 0.27	1.6	0.026	0.55	< 0.41	< 0.4	0.16	0.076	< 0.55	< 0.47	< 0.61	0.051	< 0.098	1.2	0.21	0.078	0.27	1.2	< 0.4	< 0.78
IA3-G-2012-12-13	12/13/12	< 0.031	< 0.27	1.5	0.041	1.2	< 0.41	< 0.4	0.32	0.077	< 0.55	< 0.47	< 0.61	0.078	< 0.098	1.8	0.33	0.11	0.39	1.8	< 0.4	< 0.78
IA4-G-2012-12-13	12/13/12	< 0.031	< 0.27	2.7	0.051	0.59	0.71	< 0.4	0.22	0.079	0.8	< 0.47	< 0.61	0.069	< 0.098	1.5	1.4	0.32	0.32	1.4	< 0.4	< 0.78
IA5-G-2012-12-13	12/13/12	< 0.031	< 0.27	1.4	< 0.02	0.53	< 0.41	< 0.4	0.24	0.068	< 0.55	< 0.47	< 0.61	0.043	< 0.098	1.0	0.15	0.065	0.23	1.1	< 0.4	< 0.78
PS1-G-2012-12-13	12/13/12	< 0.031	< 0.27	1.5	0.022	0.74	< 0.41	< 0.4	0.21	0.064	< 0.55	< 0.47	< 0.61	0.045	< 0.098	1.1	0.22	0.084	0.24	1.1	< 0.4	< 0.78
PS2-G-2012-12-13	12/13/12	< 0.031	< 0.27	1.6	0.024	3.8	< 0.41	< 0.4	0.21	0.077	< 0.55	< 0.47	< 0.61	0.058	< 0.098	1.4	0.24	0.084	0.30	1.4	< 0.4	< 0.78
PS3-G-2012-12-13	12/13/12	< 0.031	< 0.27	1.6	< 0.02	0.63	< 0.41	< 0.4	0.24	0.081	< 0.55	< 0.47	< 0.61	0.062	< 0.098	1.5	0.25	0.084	0.31	1.4	< 0.4	< 0.78

Table 4
Indoor, Pathway and Ambient Air Analytical Results - December 2012 to April 2013
Buildings 9, 19, 39, C, E, F, and G
Texas Instruments Incorporated
Santa Clara, California
Project: 750620701

Chemical of Concern	Sample Date	Vinyl Chloride	Chloro-ethane	Trichloro-fluro-methane	1,1-DCE	Methylene Chloride	1,1-DCA	cis-1,2-DCE	Chloroform	1,2-DCA	1,1,1-TCA	Chloro-benzene	1,2-DCB	1,4-DCB	1,1,2-TCA	Toluene	TCE	PCE	Ethyl-benzene	Total Xylenes	trans-1,2-DCE	Freon 113
Unit		($\mu g/m^3$)																				
Building G without HVAC																						
IA1-G-2012-12-30	12/30/12	< 0.031	< 0.27	1.8	0.15	0.38	< 0.41	< 0.4	0.15	0.099	0.71	< 0.47	< 0.61	0.055	< 0.098	1.6	0.67	0.18	0.3	1.4	< 0.4	0.91
DUP1-2012-12-30	12/30/12	< 0.031	< 0.27	1.6	0.11	0.40	< 0.41	< 0.4	0.15	0.089	0.73	< 0.47	< 0.61	0.057	< 0.098	1.6	0.61	0.18	0.29	1.3	< 0.4	0.88
IA2-G-2012-12-30	12/30/12	< 0.031	< 0.27	1.8	0.15	0.39	< 0.41	< 0.4	0.20	0.093	1.1	< 0.47	< 0.61	0.054	< 0.098	1.5	0.83	0.20	0.3	1.4	< 0.4	0.98
IA3-G-2012-12-30	12/30/12	< 0.031	< 0.27	1.7	0.10	0.48	< 0.41	< 0.4	0.21	0.09	0.76	< 0.47	< 0.61	0.057	< 0.098	1.6	0.62	0.18	0.32	1.4	< 0.4	0.97
IA4-G-2012-12-30	12/30/12	0.035	< 0.27	3.0	0.13	0.43	0.70	< 0.4	0.20	0.11	1.0	< 0.47	< 0.61	0.069	< 0.098	1.8	1.3	0.35	0.35	1.4	< 0.4	1.8
IA5-G-2012-12-30	12/30/12	< 0.031	< 0.27	1.7	0.14	0.40	< 0.41	< 0.4	0.17	0.09	0.81	< 0.47	< 0.61	0.057	< 0.098	1.7	0.71	0.20	0.33	1.4	< 0.4	0.95
PS1-G-2012-12-30	12/30/12	< 0.031	< 0.27	2.0	0.16	0.51	0.43	< 0.4	0.21	0.10	1.2	< 0.47	< 0.61	0.061	< 0.098	1.8	0.88	0.23	0.36	1.6	< 0.4	1.1
PS2-G-2012-12-30	12/30/12	0.034	< 0.27	1.9	0.26	0.75	< 0.41	< 0.4	0.23	0.10	0.75	< 0.47	< 0.61	0.064	< 0.098	1.9	0.86	0.22	0.36	1.6	< 0.4	1.2
PS3-G_2012-12-30	12/30/12	0.035	< 0.27	2.0	0.24	0.47	< 0.41	< 0.4	0.19	0.11	0.70	< 0.47	< 0.61	0.075	< 0.098	2.0	0.89	0.22	0.37	1.7	< 0.4	1.1
Laboratory Reporting Limit		0.013	0.014	0.29	0.02	0.18	0.021	0.02	0.025	0.021	0.028	0.024	0.031	0.031	0.028	0.019	0.028	0.035	0.022	0.066	0.02	0.39
Comparison to Background / Outdoor Ambient																						
Background (outdoor ambient for Buildings 9, 19 and G) AA1-19-2012-12-13	12/13/12	0.048	< 0.27	1.1	< 0.02	0.41	< 0.41	< 0.4	0.17	0.077	< 0.55	< 0.47	< 0.61	0.033	< 0.098	0.85	0.058	0.065	0.2	0.88	< 0.4	< 0.78
Background (outdoor ambient for Building 39) AA1-39-2012-12-18	12/18/12	< 0.031	< 0.27	1.6	< 0.02	1.7	< 0.41	< 0.4	0.086	0.073	< 0.55	< 0.47	< 0.61	< 0.031	< 0.098	0.88	0.035	0.039	0.46	2.1	< 0.4	< 0.78
Background (outdoor ambient for Buildings 9, 19 and G) AA1-19-2012-12-30	12/30/12	0.071	< 0.27	2.1	0.12	0.72	< 0.41	< 0.4	0.24	0.20	< 0.55	< 0.47	< 0.61	0.21	0.17	4.0	0.17	0.33	0.6	2.4	< 0.4	0.98
Background (outdoor ambient for Building 39) AA1-39-2013-01-06	01/06/13	< 0.031	< 0.27	1.6	< 0.02	0.52	< 0.41	< 0.4	0.21	0.099	< 0.55	< 0.47	< 0.61	0.042	< 0.098	1.4	0.072	0.052	0.29	1.3	< 0.4	< 0.78
Background (outdoor ambient for Buildings C, E, and F) AA1-F-2013-01-18	01/18/13	< 0.026	< 0.053	1.2	< 0.040	2.2	< 0.081	< 0.079	0.14	0.066	< 0.11	< 0.092	< 0.12	< 0.12	< 0.11	3.4	0.17	0.28	0.62	3.1	< 0.40	0.45
Background (outdoor ambient for Buildings C,E, and F) AA1F-2013-01-20	01/20/13	< 0.026	0.061	1.4	< 0.040	< 0.69	< 0.081	< 0.079	0.17	0.092	< 0.11	< 0.092	< 0.12	0.13	< 0.11	2.0	0.089	< 0.14	0.39	1.7	< 0.40	0.61
Comparison to Short-Term Health Based Screening Criteria[1]																						
Acute Exposure MRL[2]		1,278	39,583	NE	NE	NE	NE	810	488	NE	10,914	NE	NE	12,025	NE	3,768	NE	1,357	21,710	8,685	810	NE
Intermediate Exposure MRL[3]		77	NE	NE	79	NE	NE	810	244	NE	3,820	NE	NE	1,203	NE	NE	NE	NE	8,684	2,605	810	NE
USEPA Regional Screening Levels [4]																						
Residential Screening Level [5]		0.16	10,000	730	210	96	1.5	NE	0.11	0.094	5,200	52	210	0.22	0.15	5,200	0.43	9.4	0.97	100	63	31,000
Industrial/Commercial Screening Level [6]		2.8	44,000	3,100	880	1,200	7.7	NE	0.53	0.47	22,000	220	880	1.1	0.77	22,000	3	47	4.9	440	260	130,000
RWQCB Environmental Screening Level [7]																						
Residential		0.031	31,000	NE	210	5.2	1.5	7.3	0.46	0.12	5,200	1,000	210	0.22	0.15	310	0.59	0.41	0.97	100	63	NE
Commercial or Industrial		0.16	130,000	NE	880	26	7.7	31	2.3	0.58	22,000	4,400	880	1.1	0.77	1,300	3.0	2.1	4.9	440	260	NE

Notes:
Units in micrograms per cubic meter ($\mu g/m^3$) at 25° Celsius and 1 atmosphere.
Bold values indicate an exceedance of the commercial/industrial Residential Screening Level (RSL) or the Environmental Screening Level (ESL).
Samples identified with 'IA' were collected from areas of buildings normally occupied whereas, samples identified with 'PS' were collected from areas not occupied for 8-hours a day.
[1] - Short-term health risk based screening criteria obtained from the Agency for Toxic Substances & Disease Registry (ATSDR), Minimal Risk Levels (MRLs) for hazardous substances (July 2013)
[2] - Acute screening levels (Acute MRSs) are derived for exposure durations of 1 to 14 days.
[3] - Intermediate MRLs are derived for exposure durations of >14 to 364 days
[4] - Long-term health risk based screening criteria obtained from the United States Environmental Protection Agency (USEPA), RSLs for chemical contaminants, THQ=1.0 (November 2013).
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/docs/master_sl_table_run_NOV2013.pdf
[5] - Residential screening levels (Residential Air RSLs) are derived for exposure durations of 350 days per year and 30 years.
[6] - Commercial/Industrial screening levels (Industrial Air RSLs) are derived for exposure durations of 8 hours per day, 250 days per year and 25 years.
[7] - Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) indoor air from Table E-3, December 2013.
USEPA recommends the use of Interim TCE Indoor Air Short-Term Response Action Levels for TCE Inhalation exposure from subsurface vapor intrusion at South Bay National Priority List Sites. Commercial/Industrial prompt response action levels are calculated as the time-weighted average from the RfC - 9 $\mu g/m^3$ for an 8-hour workday; 7 $\mu g/m^3$ for a 10-hour workday. Based on input from commercial building owners and tenants, EPA Region 9 recommends use of the 10-hour workday for determining the appropriate response action levels for Commercial/Industrial buildings at the South Bay Sites. Time-weighted adjustments can be made as needed for workplaces with longer work schedules.

1,1,1-TCA - 1,1,1-trichloroethane
1,1,2_TCA - 1,1,2-trichloroethane
1,1-DCA - 1,1-dichloroethane
1,1-DCE - 1,1-dichloroethene
1,2-DCB - 1,2-dichlorobenzene
1, 2-DCA - 1,2-dichloroethane
1, 4-DCB - 1,4-dichlorobenzene
Freon 113 - trichlorotrifluoroethane
chloroethane - ethyl chloride
cis-1,2-DCE - cis-1,2-dichloroethene
Methylene Choride - Dichloromethane
PCE - tetrachloroethene
Freon 11 - trichlorofluoromethane
trans-1,2-DCE - trans-1,2-dichloroethene
TCE - trichloroethene
NE = Not established

Table 5
Sub-Slab Analytical Results - December 2012
Buildings 9, 19, 39, C, E, F, and G
Texas Instruments Incorporated
Santa Clara, California
Project: 750620701

Chemical of Concern	Sample Date	Helium	Chloro-benzene	Chloro-ethane	Chloroform	1,2-DCB	1,4-DCB	1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	Ethyl-benzene	Freon 113	Methylene Chloride	PCE	Toluene	1,1,1-TCA	1,1,2-TCA	TCE	Trichloro-fluoro-methane	Vinyl Chloride	Xylenes Total
Unit		%	**(µg/m³)**																				
Building 9																							
SS1-9-2012-12-14	12/14/12	0.12	< 9.4	< 5.4	3.9	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	< 16	< 7.1	95	15	19	< 3.0	**1,900**	< 11	< 1.3	< 27
DUP2-2012-12-14	12/14/12	0.048	< 9.4	< 5.4	3.5	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	< 16	< 7.1	94	14	18	< 3.0	**1,800**	< 11	< 1.3	< 27
SS2-9-2012-12-14	12/14/12	0.079	< 9.4	< 5.4	10	< 12	< 4.4	< 8.2	< 1.9	< 8.1	16	3.4	< 8.8	< 16	< 7.1	**380**	18	27	< 3.0	**2,500**	< 11	< 1.3	< 27
Building 19																							
SS1-19-2012-12-14	12/14/12	0.12	< 9.4	< 5.4	7.8	< 12	< 4.4	17	< 1.9	110	42	5.3	< 8.8	1,400	< 7.1	**230**	12	1,000	< 3.0	**5,300**	31	< 1.3	< 27
SS2-19-2012-12-14	12/14/12	0.28	< 9.4	< 5.4	5.5	< 12	< 4.4	< 8.2	< 1.9	14	9.2	< 1.9	< 8.8	400	< 7.1	92	< 7.7	930	< 3.0	**2,400**	13	< 1.3	< 27
Building 39																							
SS1-39-2012-12-13	12/13/12	0.028	< 9.4	< 5.4	5.0	< 12	< 4.4	110	< 1.9	37	81	6.3	< 8.8	2,500	< 7.1	210	< 7.7	300	< 3.0	**1,000**	< 11	< 1.3	< 27
DUP1-2012-12-13	12/13/12	0.026	< 9.4	< 5.4	4.9	< 12	< 4.4	110	< 1.9	37	83	6.3	< 8.8	2,800	< 7.1	210	< 7.7	300	< 3.0	**1,000**	< 11	< 1.3	< 27
SS2-39-2012-12-13	12/13/12	0.019	< 9.4	< 5.4	< 2.2	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	150	< 7.1	11	< 7.7	< 11	< 3.0	82	< 11	< 1.3	< 27
SS3-39-2012-12-13	12/13/12	0.042	< 9.4	< 5.4	< 2.2	< 12	< 4.4	9.1	< 1.9	< 8.1	55	4.7	< 8.8	540	< 7.1	54	< 7.7	33	< 3.0	**510**	< 11	< 1.3	< 27
Building C																							
SS1-C-2012-12-15	12/15/12	0.031	< 9.4	< 5.4	< 2.2	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	69	< 7.1	**5,200**	17	850	< 3.0	< 11	< 11	< 1.3	< 27
SS2-C-2012-12-15	12/15/12	< 0.005	< 9.4	< 5.4	< 2.2	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	69	< 7.1	110	< 7.7	24	< 3.0	69	24	< 1.3	< 27
SS3-C-2012-12-15	12/15/12	0.019	< 9.4	< 5.4	< 2.2	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	69	< 7.1	23	52	21	< 3.0	< 11	< 11	< 1.3	< 27
SS4-C-2012-12-15	12/15/12	< 0.005	< 9.4	< 5.4	< 2.2	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	69	< 7.1	< 8.2	36	< 11	< 3.0	< 11	< 11	< 1.3	< 27
Building E																							
SS1-E-2012-12-15	12/15/12	< 0.005	< 9.4	< 5.4	< 2.2	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	< 16	< 7.1	< 8.2	< 7.7	< 11	< 3.0	< 11	< 11	< 1.3	< 27
SS2-E_2012-12-15	12/15/12	< 0.005	< 9.4	< 5.4	8.7	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	190	< 7.1	81	8.7	46	< 3.0	**800**	38	< 1.3	< 27
Building F																							
SS1-F-2012-12-15	12/15/12	0.017	< 9.4	< 5.4	< 2.2	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	< 16	< 7.1	< 8.2	9.4	< 11	< 3.0	< 11	< 11	< 1.3	< 27
Building G																							
SS1-G-2012-12-14	12/14/12	0.016	< 9.4	< 5.4	< 2.2	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	< 16	< 7.1	< 8.2	< 7.7	< 11	< 3.0	< 11	< 11	< 1.3	< 27
SS2-G-2012-12-14	12/14/12	< 0.005	< 9.4	< 5.4	< 2.2	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	47	< 7.1	**250**	< 7.7	83	< 3.0	**660**	< 11	< 1.3	< 27
SS3-G-2012-12-14	12/14/12	0.028	< 9.4	< 5.4	< 2.2	< 12	< 4.4	< 8.2	< 1.9	< 8.1	< 8.1	< 1.9	< 8.8	< 16	< 7.1	11	< 7.7	28	< 3.0	110	< 11	< 1.3	< 27
RSLs [1]																							
Industrial/Commercial Screening Level			220	44,000	0.53	880	1.1	7.7	0.47	880	NE	260	4.9	130,000	1,200	47	22,000	22,000	0.77	3	3,100	2.8	440
RWQCB ESLs [2]																							
Commercial			4,400	130,000	2.3	880	1.1	7.7	0.58	880	31	260	4.9	NE	26	2.1	1,300	22,000	0.77	3	NE	0.16	440
Commercial RSL Corrected using 0.01 Slab Attenuation Factor [3]			22,000	4,400,000	53	88,000	110	770	47	88,000	NE	26,000	490	13,000,000	120,000	4,700	2,200,000	2,200,000	77	300	310,000	280	44,000
Commercial ESL Corrected using 0.01 Slab Attenuation Factor [3]			440,000	13,000,000	230	88,000	110	770	58	88,000	3,100	26,000	490	NE	2,600	210	130,000	2,200,000	77	300	NE	16	44,000

Notes:
Bold values indicate an exceedance of the Commercial/Industrial ESL or RSL corrected using a 0.01 slab attenuation factor.
[1] - Commercial/Industrial screening levels (Industrial Air RSLs) are derived for exposure durations of 8 hours per day, 250 days per year and 25 years.
[2] - Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) indoor air from Table E-3, December 2013.
RWQCB ESLs can be access at: http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/esl.shtml
[3] - Indoor air screening levels have been adjusted using an assumed attenuation factor of 0.01 for commercial buildings based on an evaluation of the data presented in the USEPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings. EPA 530-R-10-002. March 16.
USEPA RSL = United States Environmental Protection Agency, Regional Screening Levels
ESL = Environmental Screening Level
RWQCB = Regional Water Quality Control Board, San Francisco Bay Region

1,1,1-TCA - 1,1,1-trichloroethane
1,1,2_TCA - 1,1,2-trichloroethane
1,1-DCA - 1,1-dichloroethane
1,1-DCE - 1,1-dichloroethene
1,2-DCB - 1,2-dichlorobenzene
1, 2-DCA - 1,2-dichloroethane
1, 4-DCB - 1,4-dichlorobenzene
chloroethane - ethyl chloride
cis-1,2-DCE - cis-1,2-dichloroethene
Methylene Choride - Dichloromethane
PCE - tetrachloroethene
Freon 11 - trichlorofluoromethane
trans-1,2-DCE - trans-1,2-dichloroethene
TCE - trichloroethene
Freon 113 - trichlorotrifluoroethane
NE = Not established

Table 6
Site Building Information
Texas Instruments Incorporated
Santa Clara, California
Project: 750620701

Building Identification	Pertinent Construction Information	Size (SF)	Historical Use	Current Use	Contamination Source Areas	Anticipated Depth to Groundwater (feet below ground surface)	Remediation Information
Building A	- Two story building - Most of foundation several feet thick due to former fabrication facilities - Testing labs at southern portion of building located on a raised floor system - First floor HVAC systems operate continuously 7 days a week	Total: 110,000 1st Floor: 55,000	Former fabrication facilities	Office and laboratory space	- Tank T9/ Leak L6 (no further action required) - Tank 10/ Leak L7 (no further action required)	12-14	- **Soil Vapor Extraction:** The SVE system was located to the east and south of Building A. A total of eight SVE wells were used for the Tank T9/Leak L6 area and operated from August 1993 to January 1996 for the removal of a total of 490 lbs of VOCs. A total of six SVE wells operated in the Tank 10/Leak L7 area from November 1994 to January 1996 and removed a total of 1,037 lbs of VOCs. Closure for these two areas was requested in April 1996 and granted by the RWQCB in July 1997.
Building B	- One story building - Slab thickness not available, anticipated to be less than 1 foot.	20,800	Cafeteria	Cafeteria	- Upgradient and cross-gradient sources, including Tank T12 and Leak L4	10-12	None directly underneath building
Building 39	- Slab thickness approximately 6 inches	15,000	Various uses	1st National Credit Union (independently owned and operated)	- Upgradient and cross-gradient sources, including former Sump S3	8-10	- **Groundwater Extraction:** Groundwater extraction continues to take place to the west and north of Building 39. The groundwater extraction system is working to contain the plume's migration downgradient.
Building C	- Two story building - Foundation several feet thick in some areas due to former fabrication facilities - Former SVE system predominately abandoned in place. Three wells exist in the building along with an infiltration gallery for remediation.	Total: 140,000 1st Floor - 70,000	Former fabrication facilities and research and development activities	Office and laboratory space	- Tank T12 (no further action required) - Tank T13 (no further action required) - Leak L5 (remediation ongoing)	12-14	**- Soil Vapor Extraction:** The SVE system was located outside of western wall of building, with associated wells located within the building. SVE was implemented at the Tank T12 source area during 1992 and 1994. In 1995, it was documented that soil cleanup goals were attained at Tank T12 and SVE system operation was discontinued. Less than ten lbs of VOCs were removed from the Tank T12 source area. SVE was also implemented at Tank T13 and Leak L5 source areas, which resulted in the removal of more than 23,400 lbs of VOCs. SVE operations at the Tank T13 and Leak L5 source areas were discontinued in 2005. **- Soil Removal Action:** Approximately 1,440 tons of impacted soil was excavated from the Leak L5 source area between 21 December 2009 and 2 January 2010. **- Chemical Oxidation Treatment:** To address existing groundwater contamination beneath and downgradient of Building C and residual soil contamination in the capillary fringe, chemical oxidation treatment has been implemented. Klozur® Activated Persulfate (manufactured by FMC) along with a sodium hydroxide activator was injected across the footprint of the 2009-2010 excavation at the Leak L5 source area. Three injection events were conducted in March 2012, July 2012, and June 2013 with approximately 7,000 gallons of persulfate injected during each event. Water quality cleanup standards have not yet been achieved, though significant reductions in total VOC concentrations have occurred. Additional injection activities are anticipated to further reduce VOCs beneath and downgradient of Building C.

Table 6
Site Building Information
Texas Instruments Incorporated
Santa Clara, California
Project: 750620701

Building Identification	Pertinent Construction Information	Size (SF)	Historical Use	Current Use	Contamination Source Areas	Anticipated Depth to Groundwater (feet below ground surface)	Remediation Information
Building G	- Three story building with open lobby area extending up to the upper floors - Slab thickness approximately 6 inches - Former SVE and ozone injection/ sparging system remain in place	Total: 140,000 1st Floor - 66,000	Historical locations of Buildings 2, 3 and 4 used for semiconductor research and small-scale manufacturing. Former Building 2 housed several processes including acid/photo etching and plating onto substrates. Support facilities at Building 2 included: three zinc precipitation baths, hazardous waste transfer tanks for acid and cyanide bearing wastes, and roof mounted scrubber units. Former Building 3 was the original wafer fabrication facility at NSC and was used for metal plating of lead frames. No known sources were identified at former Building 4. Sierra Semiconductor occupied Building 4 from 1984 through 1990. Former Buildings 2, 3, and 4 were demolished by 2000 and Building G construction started the same year. Building G was constructed and used as NSC's corporate offices until 2011.	Currently unoccupied	- Former Sump S3 was located north of former Building 2 and north of the existing Building G. - Former Tank T2 was located west of former Building 3 and below the western half of the existing Building G. - Former Tank T3 was located in the alley south of former Building 3 and north of former Building 4 and near the southeast corner of the existing Building G.	8-10	**- Soil Vapor Extraction:** SVE was implemented at the Tank T2 and Tank T3 source areas to address shallow soil contamination around 1992. SVE was discontinued in 1998 pending soil closure activities in the source areas. NSC requested soil closure in 1999 (HLA, 1999). On 23 June 2000, the Water Board approved the request submitted by NSC on 27 April 2000, for permanent closure of the SVE system in operation at Buildings 2, 3, and 4 due to the fact that VOC concentrations were below cleanup levels at Tank T2, Tank T3, and Sump S3 source areas, and VOC removal rates had declined to very low levels (Water Board, 2000). **- Ozone Injection/Sparging:** NSC implemented ozone sparging for treatment of the saturated zone in the Tank T2 and Tank T3 areas in 2000 (SECOR, 2000a and SECOR, 2000b). An ozone sparging system with vapor capture using SVE was installed during construction of Building G which currently overlies the Tank T2 and Tank T3 source areas. National expanded the OS/SVE system into the parking lot of Building G prior to completion of the building (SECOR, 2002). The OS/SVE system operated from 2002 to 2008. Ozone sparging beneath Building G in the T2 and T3 source areas was discontinued in 2007 based on the results of a limited Geoprobe® investigation documenting that groundwater concentrations for total VOCs were below 500 ug/L (SECOR, 2007).Treatment was halted in the Building G parking lot in 2008 due to limited treatment effectiveness in the S3 source area. Elevated concentrations of ethylbenzene and xylenes, low permeability clay soils, and a low density of treatment wells are believed to have contributed to the limited effectiveness of ozone sparging in the S3 source area. **- Fenton's Reagent:** NSC implemented Fenton's Reagent in the S3 source area in 2009 (Stantec, 2010). Fenton's Reagent was found to have limited effectiveness in the low permeability soils. **- Enhanced In Situ Bioremediation:** NSC conducted a pilot study to evaluate Enhanced In Situ Bioremediation in 2011 and 2012 (EISB, Stantec, 2011). NSC selected SiRem Laboratories (SiRem) KB-1-Plus microbial inoculum to enhance TCE biodegradation and that of chlorobenzenes and 1,1,1-TCA. Preliminary results of the pilot study indicate that the treatment can be implemented effectively to remediate VOCs in the S3 source area (Stantec, 2012).
Building M	- Small two-story building between Buildings A and C - Slab thickness approximately 6-inches to several feet	Total: 12,000 1st Floor - 6,000	Various uses	Office and laboratory space	- Cross-gradient sources include Tank T10 and Tank T12	12-14	None directly underneath building
Building W	- Slab thickness ranges from 6 inches to several feet, with a thicker slab in the shipping and receiving warehouse area rated for forklift traffic	Total: 45,000	Office space	Office and laboratory space, shipping and receiving warehouse	None	12-14	None

Table 7
Proposed Soil Gas and Air Samples
Texas Instruments Incorporated
Santa Clara, California
Project: 750620701

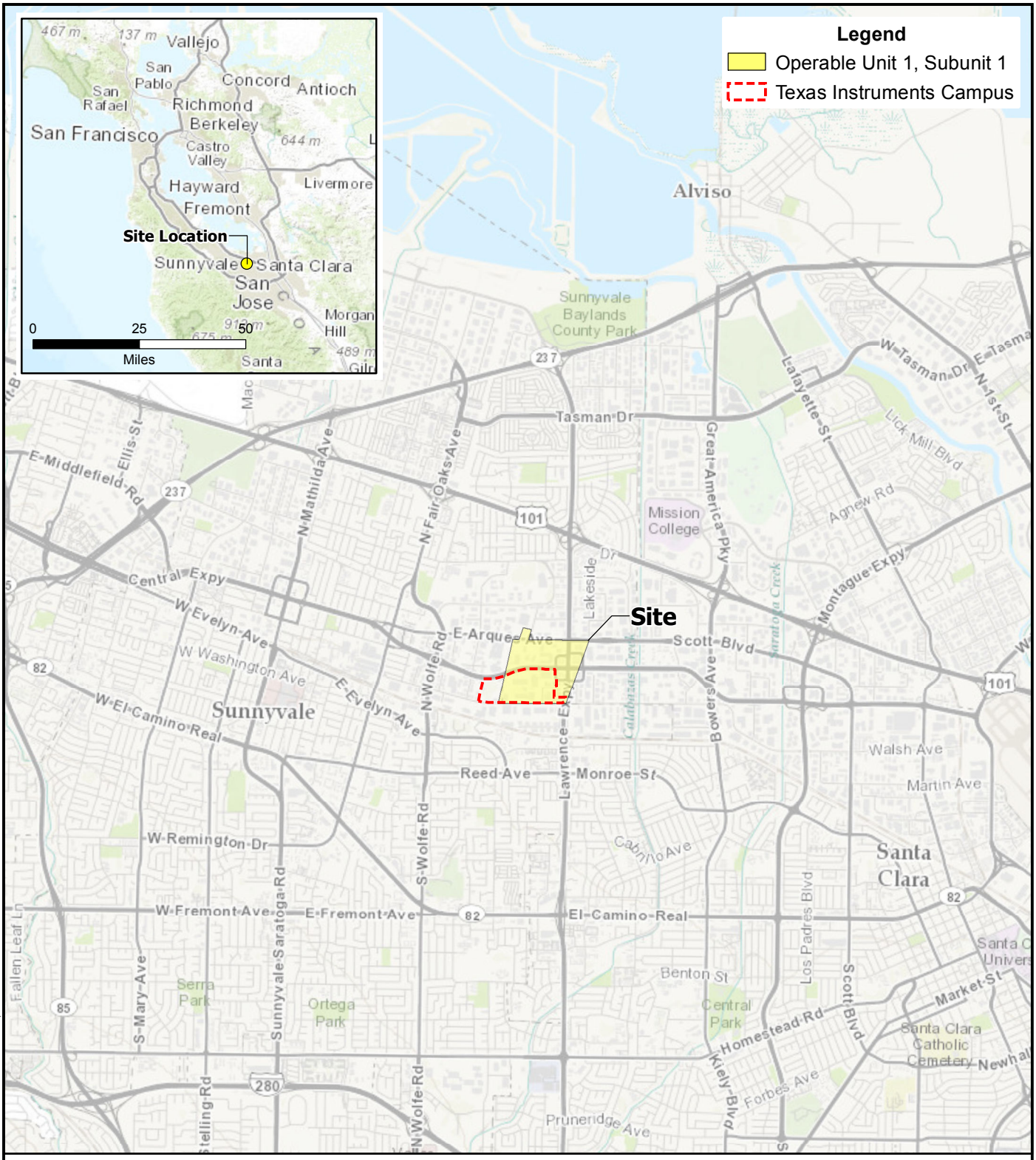
Proposed Sample ID	Matrix	HVAC On	HVAC Off	Location
Building A				
SS1-A-2014-mm-dd	Sub-Slab	X		See Figure 6
IA1-A-2014-mm-dd	Indoor Air	X		See Figure 6
IA2-A-2014-mm-dd	Indoor Air	X		See Figure 6
IA3-A-2014-mm-dd	Indoor Air	X		See Figure 6
IA4-A-2014-mm-dd	Indoor Air	X		See Figure 6
PS1-A-2014-mm-dd	Pathway	X		See Figure 6
PS2-A-2014-mm-dd	Pathway	X		See Figure 6
PS3-A-2014-mm-dd	Pathway	X		See Figure 6
PS4-A-2014-mm-dd	Pathway	X		See Figure 6
PS5-A-2014-mm-dd	Pathway	X		See Figure 7
AA-A-2014-mm-dd	Ambient Air [1]	X		Roof, within 10 feet of HVAC
Building B				
SS1-B-2014-mm-dd	Sub-Slab	X		See Figure 8
SS2-B-2014-mm-dd	Sub-Slab	X		See Figure 8
IA1-B-2014-mm-dd	Indoor Air	X	X	See Figure 8
IA2-B-2014-mm-dd	Indoor Air	X	X	See Figure 8
IA3-B-2014-mm-dd	Indoor Air	X	X	See Figure 8
PS1-B-2014-mm-dd	Pathway	X	X	See Figure 8
PS2-B-2014-mm-dd	Pathway	X	X	See Figure 8
PS3-B-2014-mm-dd	Pathway	X	X	See Figure 8
AA-B-2014-mm-dd	Ambient Air [1]	X	X	Roof, within 10 feet of HVAC
Building C				
IA1-C-2014-mm-dd	Indoor Air	X	X	See Figure 9
IA2-C-2014-mm-dd	Indoor Air	X	X	See Figure 9
IA3-C-2014-mm-dd	Indoor Air	X	X	See Figure 9
IA4-C-2014-mm-dd	Indoor Air	X	X	See Figure 9
IA5-C-2014-mm-dd	Indoor Air	X	X	See Figure 9
PS1-C-2014-mm-dd	Pathway	X	X	See Figure 9
PS2-C-2014-mm-dd	Pathway	X	X	See Figure 9
PS3-C-2014-mm-dd	Pathway	X	X	See Figure 9
PS4-C-2014-mm-dd	Pathway	X	X	See Figure 10
AA-C-2014-mm-dd	Ambient Air [1]	X	X	Roof, within 10 feet of HVAC
Building G				
IA1-G-2014-mm-dd	Indoor Air	X	X	See Figure 11
IA2-G-2014-mm-dd	Indoor Air	X	X	See Figure 11
IA3-G-2014-mm-dd	Indoor Air	X	X	See Figure 11
IA4-G-2014-mm-dd	Indoor Air	X	X	See Figure 11
PS1-G-2014-mm-dd	Pathway	X	X	See Figure 11
PS2-G-2014-mm-dd	Pathway	X	X	See Figure 11
PS3-G-2014-mm-dd	Pathway	X	X	See Figure 11
PS4-G-2014-mm-dd	Pathway	X	X	See Figure 12
AA-G-2014-mm-dd	Ambient Air [1]	X	X	Roof, within 10 feet of HVAC
Building M				
SS1-M-2014-mm-dd	Near-Slab	X		See Figure 13
IA1-M-2014-mm-dd	Indoor Air	X		See Figure 13
IA2-M-2014-mm-dd	Indoor Air	X		See Figure 13
PS1-M-2014-mm-dd	Pathway	X		See Figure 13
AA-M-2014-mm-dd	Ambient Air [1]	X		Roof, within 10 feet of HVAC

Table 7
Proposed Soil Gas and Air Samples
Texas Instruments Incorporated
Santa Clara, California
Project: 750620701

Proposed Sample ID	Matrix	HVAC On	HVAC Off	Location
Building W				
SS1-W-2014-mm-dd	Near-Slab	X		See Figure 14
IA1-W-2014-mm-dd	Indoor Air	X	X	See Figure 14
IA2-W-2014-mm-dd	Indoor Air	X	X	See Figure 14
IA3-W-2014-mm-dd	Indoor Air	X	X	See Figure 14
IA4-W-2014-mm-dd	Indoor Air	X	X	See Figure 14
IA5-W-2014-mm-dd	Indoor Air	X	X	See Figure 14
PS1-W-2014-mm-dd	Pathway	X	X	See Figure 14
AA-F-2012-mm-dd	Ambient Air [1]	X	X	Roof, within 10 feet of HVAC
Building 39				
IA1-39-2014-mm-dd	Indoor Air	X	X	See Figure 16
IA2-39-2014-mm-dd	Indoor Air	X	X	See Figure 16
IA3-39-2014-mm-dd	Indoor Air	X	X	See Figure 16
PS1-39-2014-mm-dd	Pathway	X	X	See Figure 16
PS2-39-2014-mm-dd	Pathway	X	X	See Figure 16
AA-39-2014-mm-dd	Ambient Air [1]	X	X	Roof, within 10 feet of HVAC
Duplicate Samples [1]				
DUP1-2014-mm-dd	Indoor Air	X		TBD
DUP2-2014-mm-dd	Indoor Air	X		TBD
DUP3-2014-mm-dd	Indoor Air	X		TBD
DUP4-2014-mm-dd	Pathway	X		TBD
DUP5-2014-mm-dd	Ambient Air [1]	X		TBD
DUP6-2014-mm-dd	Indoor Air		X	TBD
DUP7-2014-mm-dd	Indoor Air		X	TBD
DUP8-2014-mm-dd	Pathway		X	TBD
DUP9-2014-mm-dd	Ambient Air [1]		X	TBD
DUP10-2014-mm-dd	Sub-Slab	X		TBD

Notes:
1 - Ambient air samples will be collected at a frequency of one per day.
2 - Duplicate samples will be collected at a frequency of 10% primary samples
mm = month
dd= day
TBD = to be determined

FIGURES



Notes:

1. Basemap provided © 2010 NAVTEQ © AND © 2013 Microsoft Corporation.
2. Map displayed in California State Plane Coordinate System, Zone III, North American Datum of 1983 (NAD83), US Survey Feet.

0 0.5 1 2
Miles

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W E
S

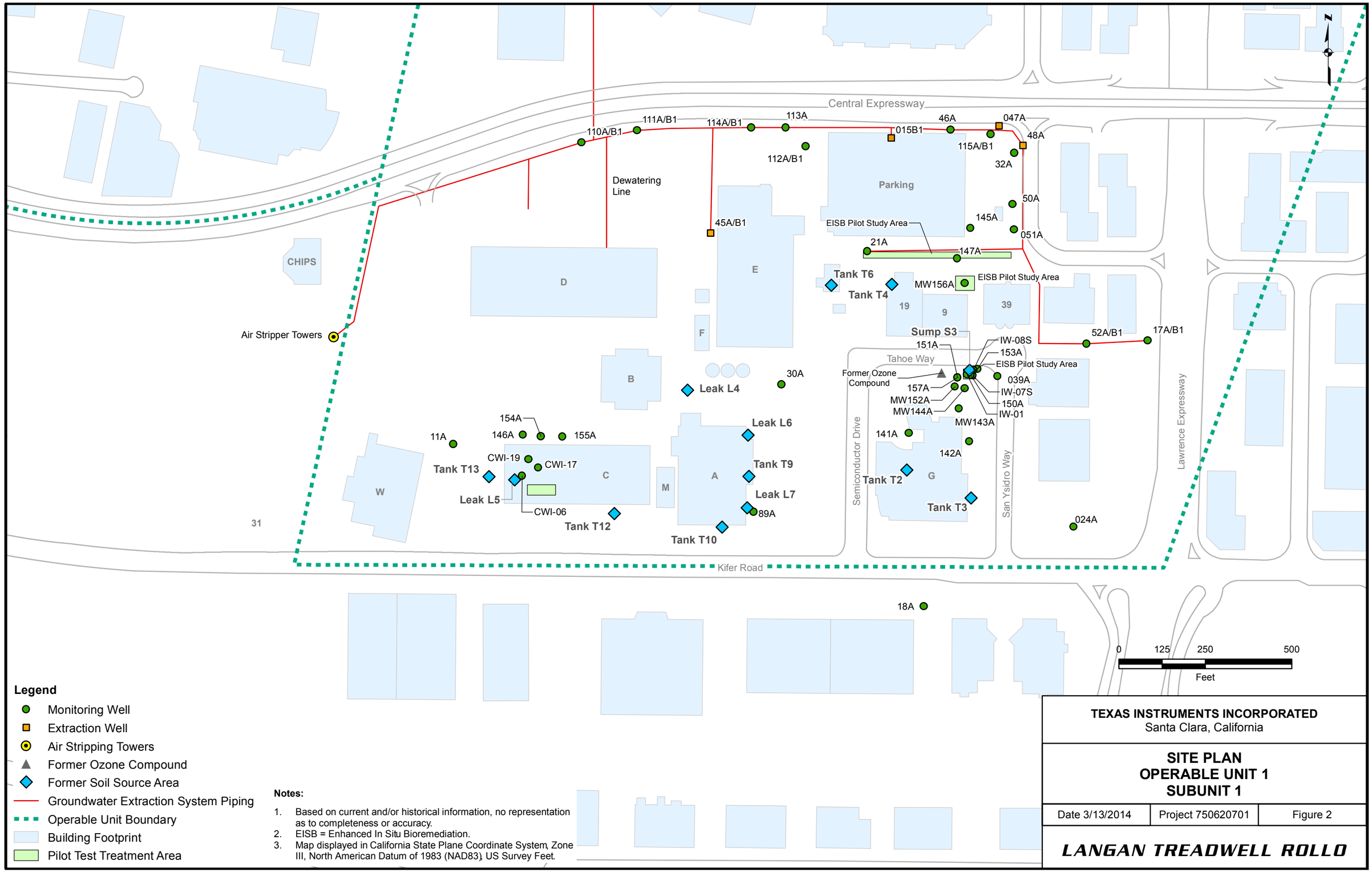
TEXAS INSTRUMENTS INCORPORATED
Santa Clara, California

SITE LOCATION MAP

LANGAN TREADWELL ROLLO

Date 3/13/2014	Project 750620701	Figure 1

\\langan.com\data\SF\data9\730377972\ArcGIS\arcmap_doc\2013\WorkPlan\SiteLocationMap.mxd



Legend

- Monitoring Well
- Extraction Well
- Air Stripping Towers
- Former Ozone Compound
- Former Soil Source Area
- Groundwater Extraction System Piping
- Operable Unit Boundary
- Building Footprint
- Pilot Test Treatment Area

Notes:

1. Based on current and/or historical information, no representation as to completeness or accuracy.
2. EISB = Enhanced In Situ Bioremediation.
3. Map displayed in California State Plane Coordinate System, Zone III, North American Datum of 1983 (NAD83), US Survey Feet.

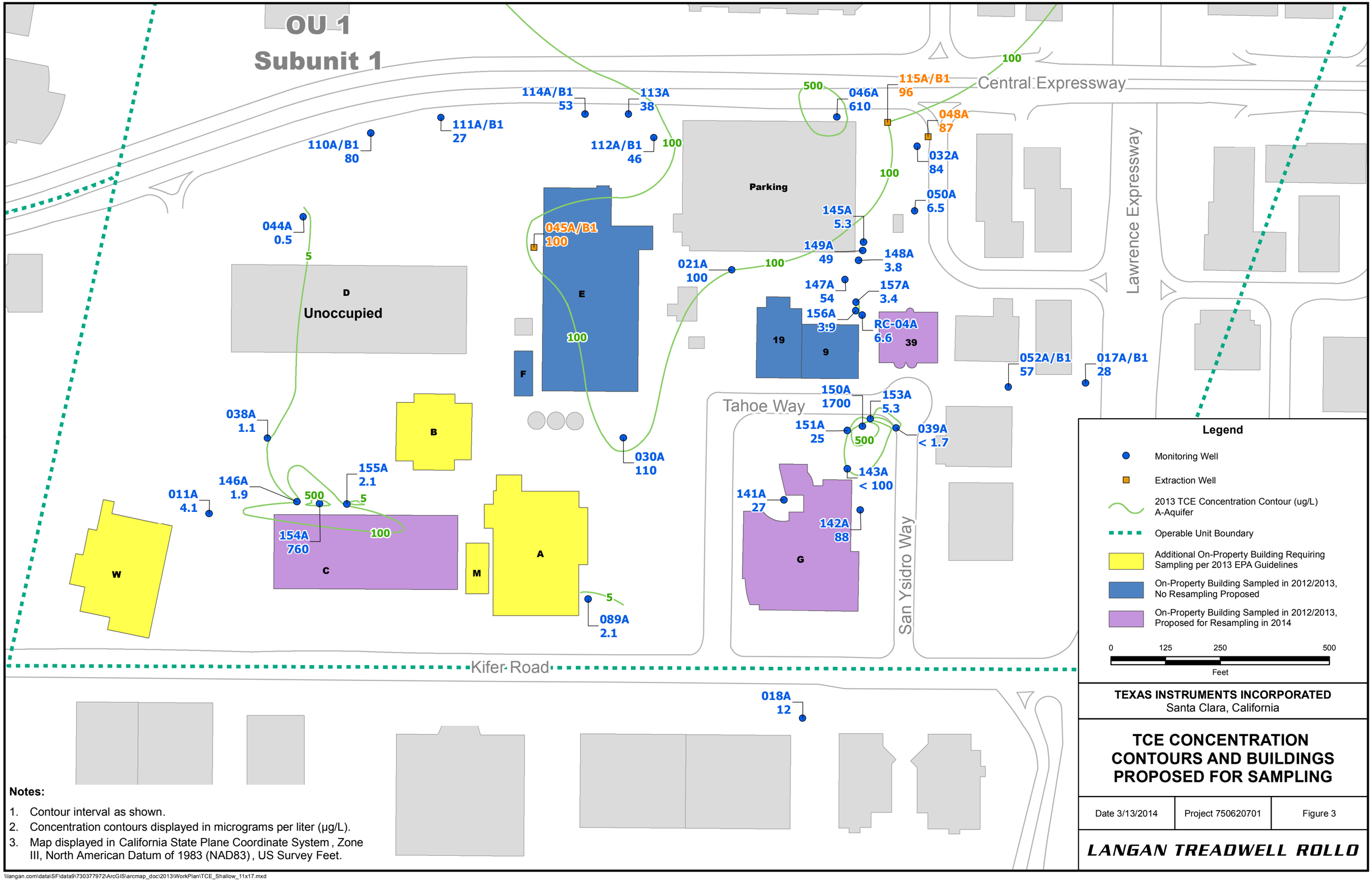
TEXAS INSTRUMENTS INCORPORATED
Santa Clara, California

SITE PLAN
OPERABLE UNIT 1
SUBUNIT 1

Date 3/13/2014	Project 750620701	Figure 2

LANGAN TREADWELL ROLLO

\\langan.com\data\SF\data9\730377972\ArcGIS\arcmap_doc\2013\WorkPlan\Site Plan.mxd



Notes:

1. Contour interval as shown.
2. Concentration contours displayed in micrograms per liter (µg/L).
3. Map displayed in California State Plane Coordinate System, Zone III, North American Datum of 1983 (NAD83), US Survey Feet.

TEXAS INSTRUMENTS INCORPORATED
Santa Clara, California

TCE CONCENTRATION CONTOURS AND BUILDINGS PROPOSED FOR SAMPLING

Date 3/13/2014	Project 750620701	Figure 3

LANGAN TREADWELL ROLLO

\\langan.com\data\SF\data9\730377972\ArcGIS\arcmap_doc\2013\WorkPlan\TCE_Shallow_11x17.mxd

N
W E
S

Highway 101
East Duane Ave
Lawrence Expressway
Lakeside Drive
Oakmead Parkway
Stewart Drive
East Arques Ave
Central Expressway
Tahoe Way
San Ysidro Way
Kifer Road
Railroad Tracks

SDOU
CSOU
OU 1
Subunit 1
OU 1
Subunit 2
OU 1
Subunit 3

097A/B1 11.48
128A 13.57
139A 22.96
069A 24.8
070A 27.4
MM40A 26.02
MM34A 27.45
136A 28.97
137A 27.23
MM14A 19.17
ME41A 26.8
LF13 32.37
LF14 32.3
LF15 32.79
MM07A 30.97
ME43A 32.71
MM37A 31.4
MM17A 33.54
MM31A 34.42
MM12A 23.12
MM01A 32.97
MM33A 30.83
068A 30.13
LF12 35.36
LF01 35.23
LF24 34.67
LF17 35.11
106A/B1 16.16
104A/B1 34.03
102A/B1 31.01
105A/B1 35.34
103A 33.82
101A 31.94
098A/B1 17.76
M06A 36.06
M07A 35.73
M22A 35.28
M08A 35.64
M09A 34.1
108A/B1 16.48
LF21 34.98
LF20 35.84
M12A 39.83
M20A 39.67
M24A 37.96
M18A 37.65
M19A 35.21
M13A 40.28
LF18 38.41
LF07 40
M05A 40.86
M17A 36.28
M10A 38.94
LF19 39.28
M16A 39.54
072A 29.8
071A/B1 28.26
057A 33.52
023A 32.9
062A 32.35
058A 36.66
M04A 41.86
U14B 41.88
LF09 41.91
LF10 41.6
M03A 41.9
LF08 42.38
111A/B1 42.68
113A 42.56
063A 39.65
115A/B1 36.71
047A 37.36
048A 35.48
M02A 42.17
M01A 42.83
059A 42.42
110A/B1 42.61
114A/B1 41.77
112A/B1 40.92
046A 37.96
049A 36.93
032A 36.57
050A 37.65
044A 43.55
041A 43.59
045A/B1 39.35
145A 39.33
149A 39.17
147A 41.09
148A 39.48
021A 41.89
031A 43.24
027A/B1 35.17
052A/B1 39.68
053A/B1 38.96
017A/B1 39.34
008A 41.02
030A 44.08
153A 46.77
144A 44.83
039A 39.72
143A 43
038A 44.98
011A 46.01
154A 45.14
155A 45.19
036A 45.25
010A 45.98
141A 43.44
142A 43.41
089A 44.63
087A 48.92
006A 45.06
018A 45.19
043A/B1 48.54
019A/B1 50.16

Legend

- Monitoring Well
- Extraction Well
- Operable Unit Boundary
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

0 125 250 500 750
Feet

Notes:

1. Contour interval = 5 feet.
2. MW-18AR and 150A Were not used for contouring.
3. Water levels measured by Treadwell & Rollo on 14 October 2013.
4. Groundwater elevations displayed in US Survey Feet with respect to the National Geodetic Vertical Datum of 1929 (NGVD29).
5. Map displayed in California State Plane Coordinate System, Zone III, North American Datum of 1983 (NAD83), US Survey Feet.

TEXAS INSTRUMENTS INCORPORATED
Santa Clara, California

A-AQUIFER GROUNDWATER ELEVATION CONTOUR MAP OCTOBER 2013

Date 3/13/2014	Project 730377985	Figure 4

LANGAN TREADWELL ROLLO

\\langan.com\data\SF\data9\730377972\ArcGIS\arcmap_doc\2013 Annual Groundwater Monitoring\Groundwater Elevation - A Aquifer.mxd

CENTRAL EXPRESSWAY

GARAGE

CHIPS

EMPLOYEE PARKING

D

E

A

B

C

W

M

31

147A

142A

30A

Solvent Pad

Q.I.

ENOCHS

TAHOE WAY

SEMICONDUCTOR DR.

SAN YSIDRO WAY

LAWRENCE EXPRESSWAY

KIFER ROAD

SG-1 SG-2 SG-3 SG-5 SG-6 SG-7 SG-8

A-1 A-2 A-3 A-4 A-5 A-6

IA1 IA2 IA3 IA4 IA5 IA6 IA7 IA-1 IA-2 IA-3 IA-4 IA-5 IA-6 IA-D4 IA-F4 IA-AL3

PS1 PS2 PS3 PS4

SS1 SS2 SS3 SS4

IA-1 IA-2 IA-3 IA-4 IA-5 IA-6

PS1 PS2 PS3

SS1 SS2

EXPLANATION

2004, 2006 & 2007		2012 & 2013	
SG-1	Soil gas sample location	SS1	Sub-slab gas sample location
IA-1	Indoor air sampling location	IA1	Indoor air sampling location
A-1	Ambient air sampling location	PS1	Pathway sampling location

0 200 Feet

Approximate Scale

Source: "NSC Building Site Parking Spaces" - 6 January 2003, National Semiconductor Co.

TEXAS INSTRUMENTS
Santa Clara, California

HISTORICAL INDOOR AIR, PATHWAY, SOIL GAS AND AMBIENT AIR SAMPLING LOCATIONS

Date 02/24/14	Project No. 750620701	Figure 5

LANGAN TREADWELL ROLLO

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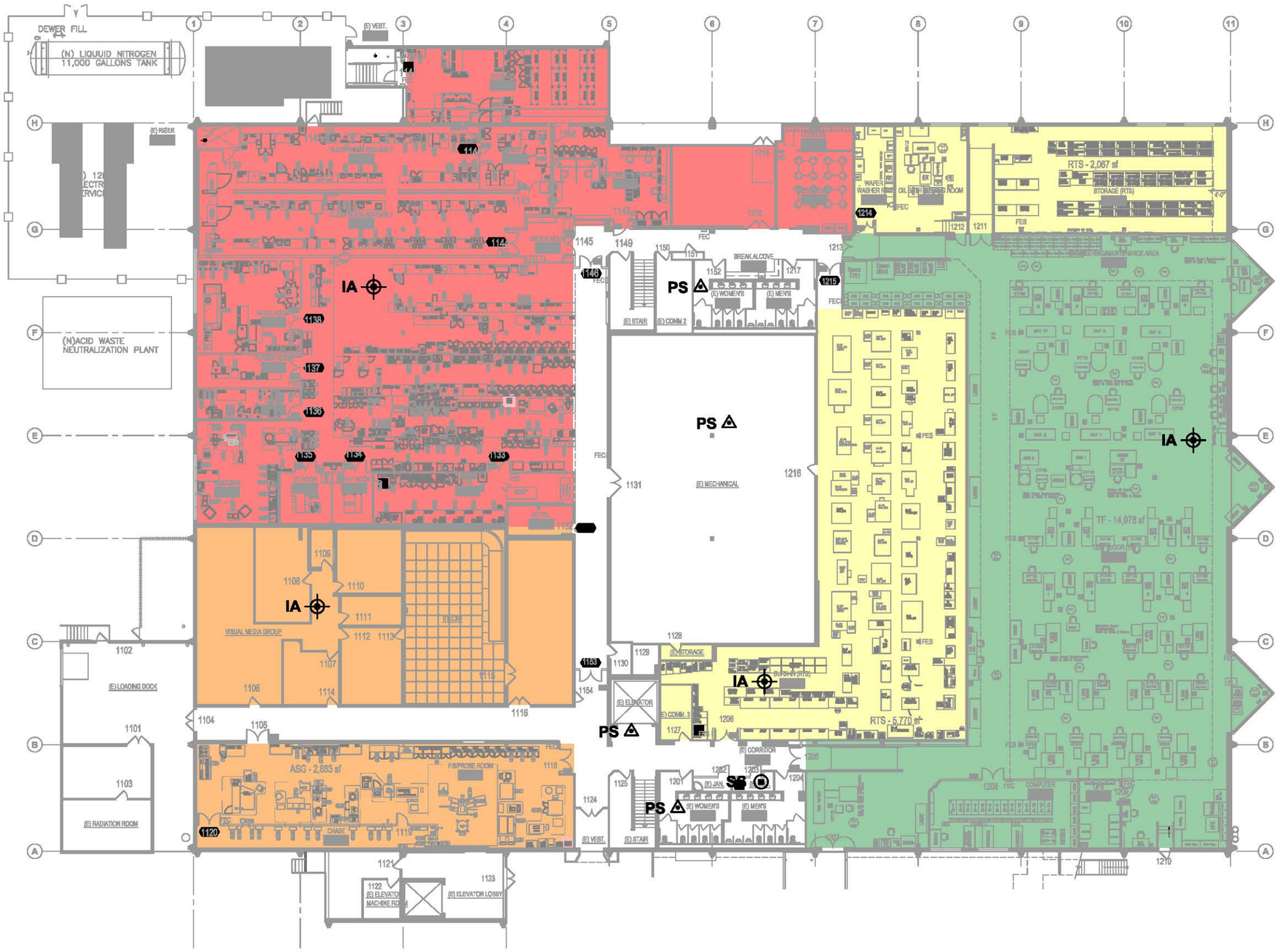

EXPLANATION

- Air Handling 4, operates continuously
- Air Handling 5, operates continuously
- Air Handling 11, operates continuously
- Air Handling 4 Fresh air, operates continuously
- IA — Proposed indoor air sample
- PS — Proposed pathway sample
- SS — Proposed sub-slab sample

Note: HVAC off samples will not be collected in areas where HVAC operates continuously (24/7)

0 30 Feet
Approximate scale

Reference: Base map from a drawing titled, "Building A-1 AsBuilt," by Texas Instruments, dated 11/16/12.

TEXAS INSTRUMENTS
Santa Clara, California

INTERIOR FLOOR PLAN AND AIR HANDLING AREAS WITH PROPOSED SAMPLE LOCATIONS - BUILDING A-1

Date 03/03/14 | Project No. 750620701 | Figure 6

LANGAN TREADWELL ROLLO

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EXPLANATION

- Air Handling 4
- Air Handling 5
- Air Handling 6

PS ◬ Proposed pathway sample

0 30 Feet

Approximate scale

Reference: Base map from a drawing titled, "Building A-2 AsBuilt," by Texas Instruments, dated 06/20/13.

TEXAS INSTRUMENTS
Santa Clara, California

INTERIOR FLOOR PLAN AND AIR HANDLING AREAS WITH PROPOSED SAMPLE LOCATIONS - BUILDING A-2

Date 03/03/14	Project No. 750620701	Figure 7

LANGAN TREADWELL ROLLO

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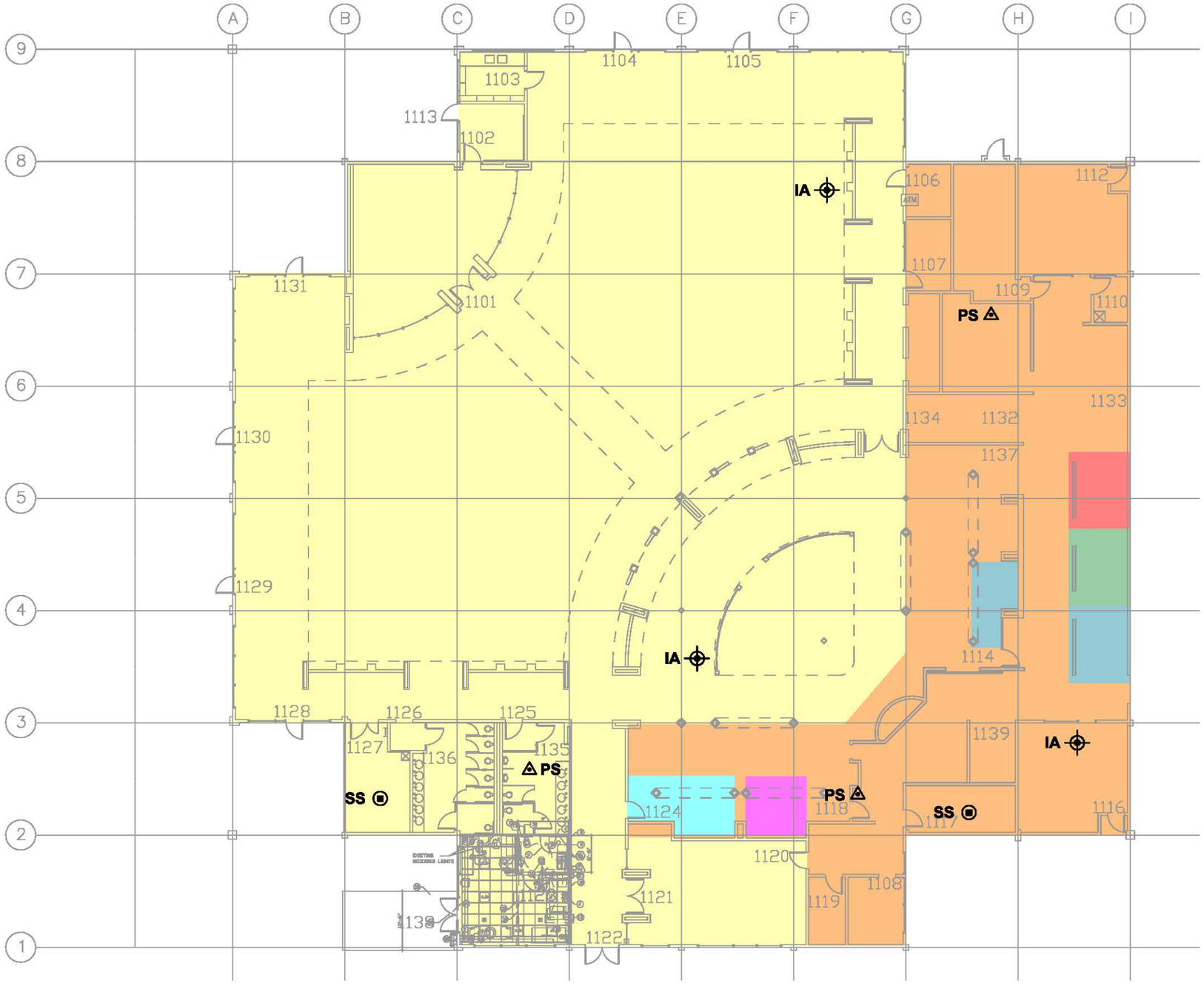

EXPLANATION

- Air Handling 1
- Air Handling 2
- Supply Unit 1
- Supply Unit 2
- Supply Unit 3
- Supply Unit 4
- Supply Unit 5
- IA — Proposed indoor air sample
- PS — Proposed pathway sample
- SS — Proposed sub-slab sample

0 20 Feet

Approximate scale

Reference: Base map from a drawing titled, "Building B AsBuilt," by Texas Instruments, dated 06/14/13.

TEXAS INSTRUMENTS
Santa Clara, California

INTERIOR FLOOR PLAN AND AIR HANDLING AREAS WITH PROPOSED SAMPLE LOCATIONS - BUILDING B

Date 02/24/14	Project No. 750620701	Figure 8

LANGAN TREADWELL ROLLO

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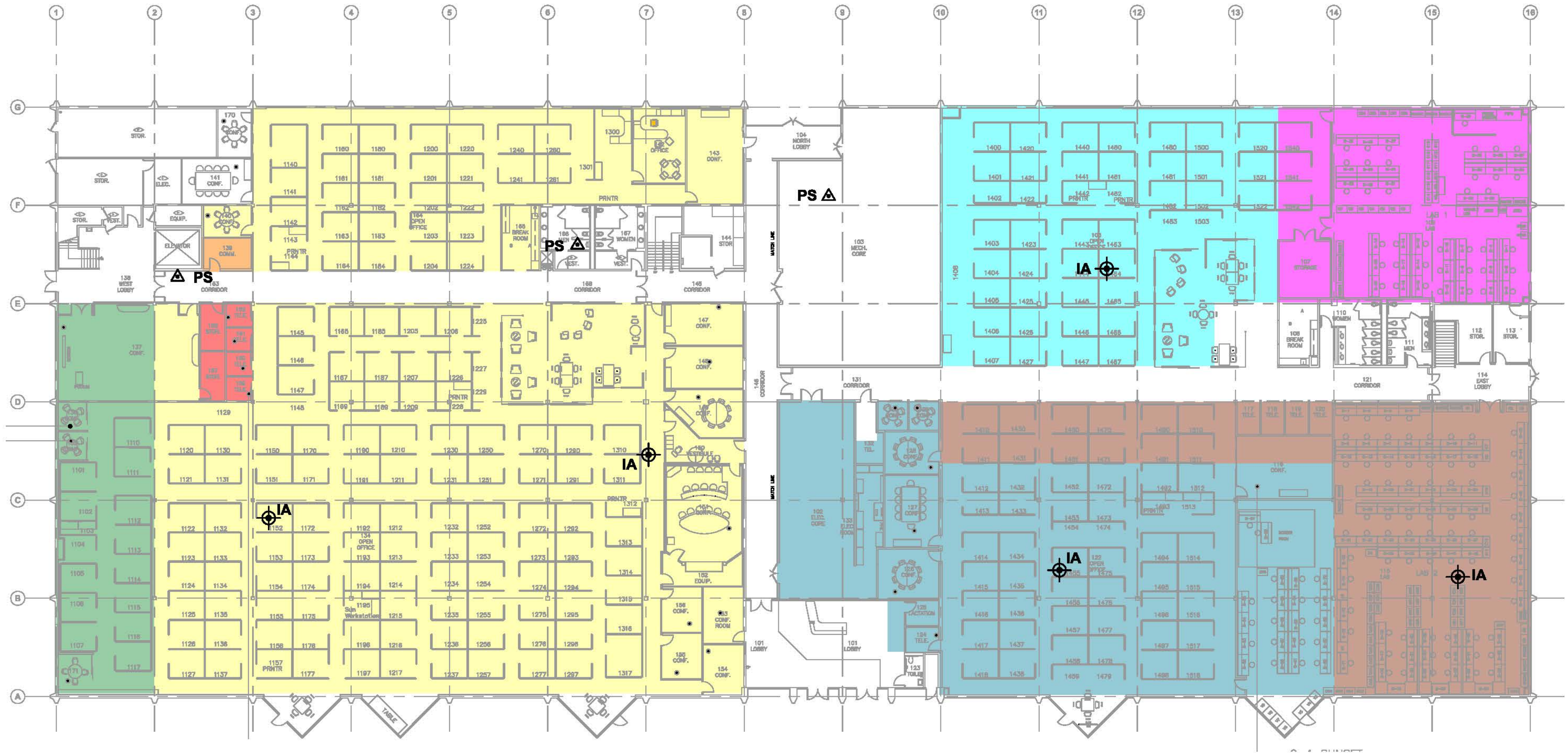

EXPLANATION

Color	Area	Color	Area
(yellow)	Air Handling 1	(blue)	Air Handling 1
(orange)	Fan Coil 1	(cyan)	Air Handling 2
(red)	Fan Coil 2	(magenta)	Air Handling 3
(green)	Fan Coil 3	(brown)	Air Handling 4

IA ⌖ Proposed indoor air sample

PS △ Proposed pathway sample

Note: Indoor and pathway air sample locations were previously approved by the EPA and Water Board following building surveys. These locations were previously sampled in the winter of 2012/2013. These locations are proposed for re-testing in 2014.

0 — 30 Feet
Approximate scale

Reference: Base map from a drawing titled, "Building C-1 Asbuilt Office Layout," by Texas Instruments, dated 10/02/12.

TEXAS INSTRUMENTS
Santa Clara, California

INTERIOR FLOOR PLAN AND AIR HANDLING AREAS WITH PROPOSED SAMPLE LOCATIONS - BUILDING C-1

Date 02/24/14	Project No. 750620701	Figure 9

LANGAN TREADWELL ROLLO

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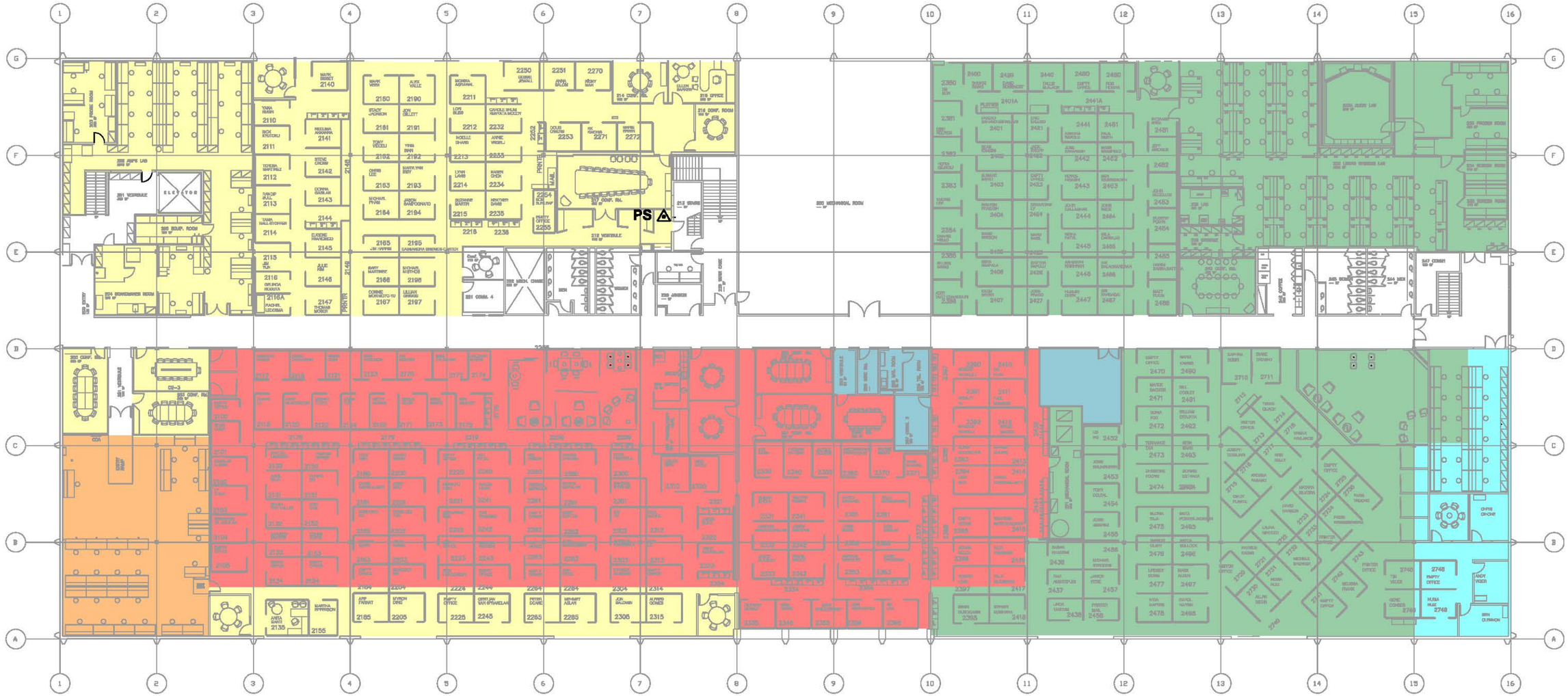

EXPLANATION

- Air Handling 1
- Air Handling 2
- Air Handling 3
- Air Handling 4
- Air Handling 5
- Air Handling 6

PS Proposed pathway sample

Note: Indoor and pathway air sample locations were previously approved by the EPA and Water Board following building surveys. These locations were previously sampled in the winter of 2012/2013. These locations are proposed for re-testing in 2014.

0 30 Feet

Approximate scale

Reference: Base map from a drawing titled, "Building C-2 Asbuilt Office Layout," by Texas Instruments, dated 10/03/12.

TEXAS INSTRUMENTS
Santa Clara, California

INTERIOR FLOOR PLAN AND AIR HANDLING AREAS WITH PROPOSED SAMPLE LOCATIONS - BUILDING C-2

Date 02/24/14	Project No. 750620701	Figure 10

LANGAN TREADWELL ROLLO

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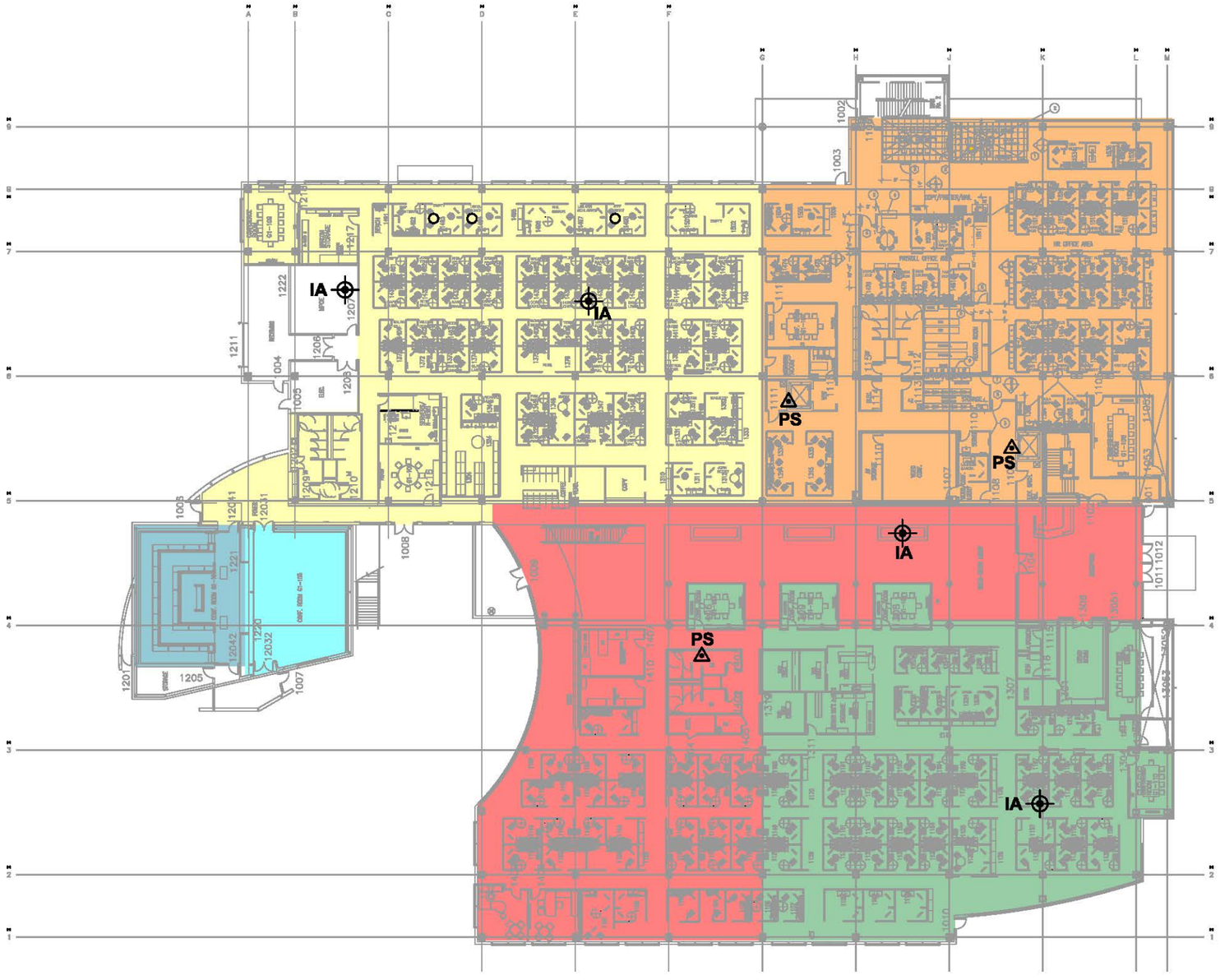

EXPLANATION

- Air Handling Unit A/H-1G
- Air Handling Unit A/H-2G
- Air Handling Unit A/H-3G
- Air Handling Unit A/H-4G
- Air Handling Unit A/H-6G
- Air Handling Unit A/H-7G

IA Proposed indoor air sample

PS Proposed pathway sample

Note: Indoor and pathway air sample locations were previously approved by the EPA and Water Board following building surveys. These locations were previously sampled in the winter of 2012/2013. These locations are proposed for re-testing in 2014.

0 40 Feet

Approximate scale

Reference: Base map from a drawing titled, "Building G-1 Floor Plan," by Texas Instruments, dated 12/13/11.

TEXAS INSTRUMENTS
Santa Clara, California

INTERIOR FLOOR PLAN AND AIR HANDLING AREAS WITH PROPOSED SAMPLE LOCATIONS - BUILDING G-1

Date 02/24/14	Project No. 750620701	Figure 11

LANGAN TREADWELL ROLLO

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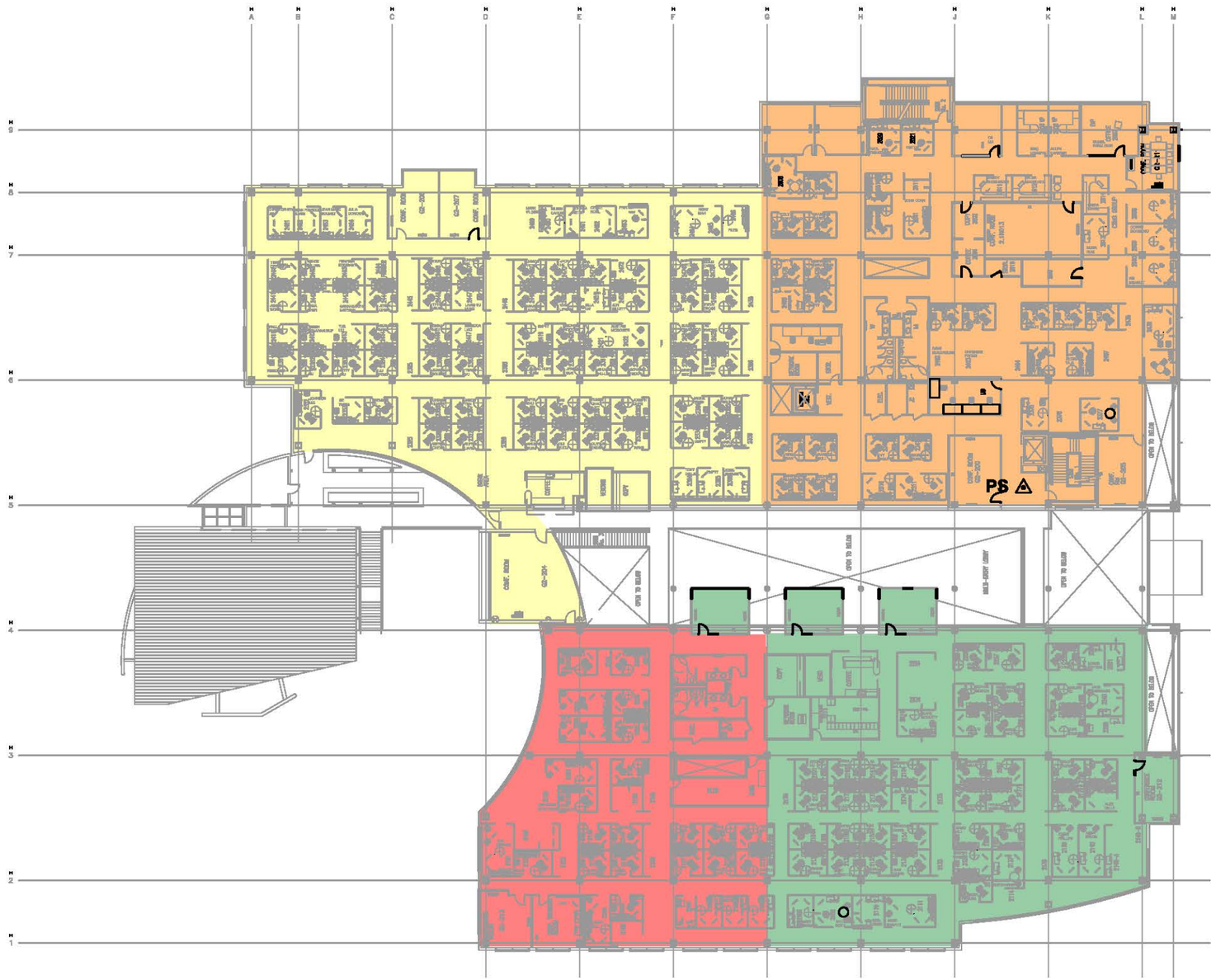

EXPLANATION

- Air Handling Unit A/H-1G
- Air Handling Unit A/H-2G
- Air Handling Unit A/H-3G
- Air Handling Unit A/H-4G

PS Proposed pathway sample

Note: Indoor and pathway air sample locations were previously approved by the EPA and Water Board following building surveys. These locations were previously sampled in the winter of 2012/2013. These locations are proposed for re-testing in 2014.

0 40 Feet

Approximate scale

Reference: Base map from a drawing titled, "Building G-2 Floor Plan," by Texas Instruments, dated 04/11/11.

TEXAS INSTRUMENTS
Santa Clara, California

INTERIOR FLOOR PLAN AND AIR HANDLING AREAS WITH PROPOSED SAMPLE LOCATIONS - BUILDING G-2

Date 02/24/14 | Project No. 750620701 | Figure 12

LANGAN TREADWELL ROLLO

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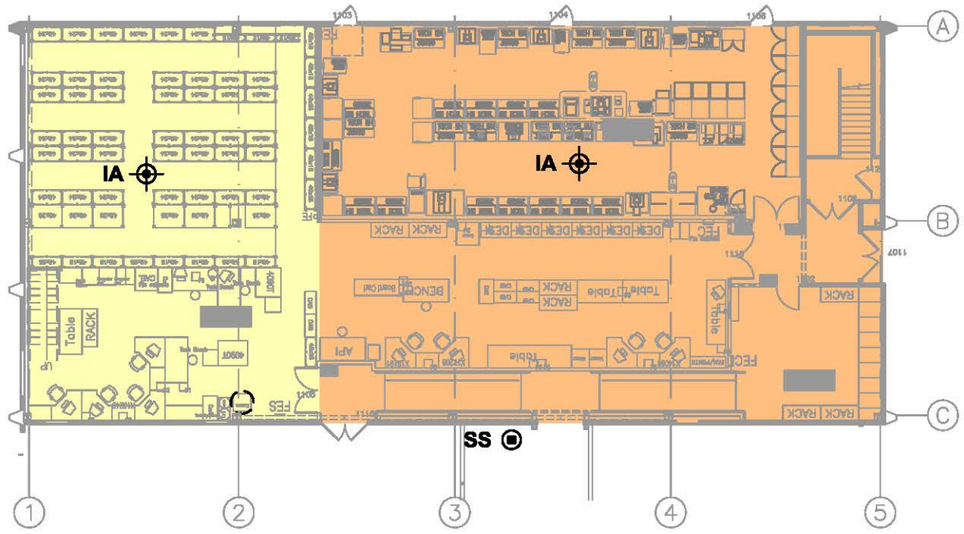
BUILDING M1

EXPLANATION

- Air Conditioning 1, operates continuously
- Air Conditioning 2, operates continuously
- IA — Proposed indoor air sample
- SS — Proposed sub-slab sample

Note: HVAC off samples will not be collected in areas where HVAC operates continuously (24/7)



BUILDING M2

EXPLANATION

- Air Conditioning 3
- Air Conditioning 4
- Air Conditioning 5
- PS — Proposed pathway sample

0 20 Feet

Approximate scale

Reference: Base map from a drawing titled, "Building M-1" and "Building M-2," by Texas Instruments, dated 06/14/13 and 06/20/13 respectively.

TEXAS INSTRUMENTS
Santa Clara, California

INTERIOR FLOOR PLAN AND AIR HANDLING AREAS WITH PROPOSED SAMPLE LOCATIONS - BUILDING M-1 & M-2

Date 03/03/14 | Project No. 750620701 | Figure 13

LANGAN TREADWELL ROLLO

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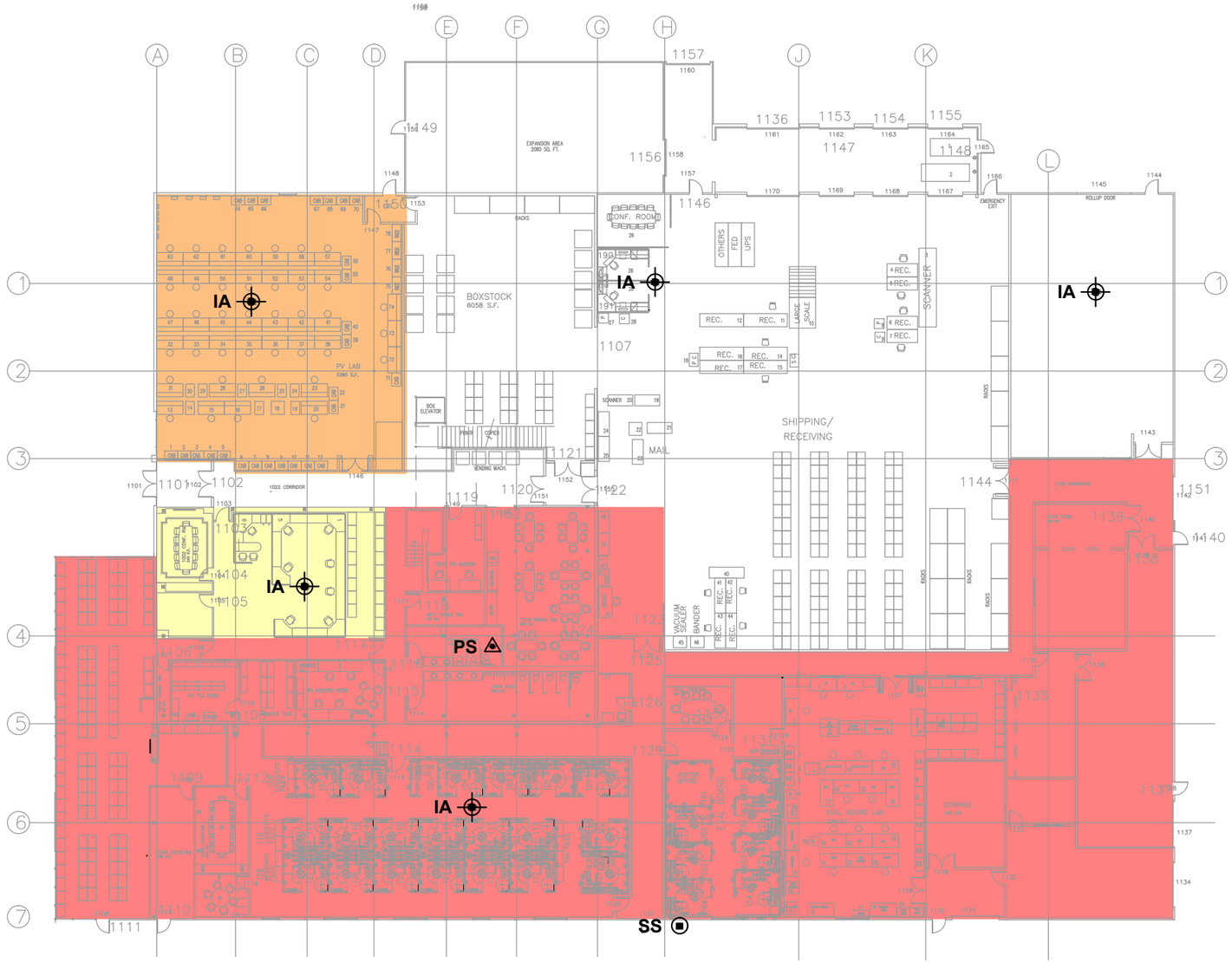

EXPLANATION

	Air Conditioning 6	IA	Proposed indoor air sample
	Air Conditioning 7	PS	Proposed pathway sample
	Air Conditioning 9	SS	Proposed sub-slab sample

0 30 Feet

Approximate scale

Reference: Base map from a drawing titled, "Building W-1 AsBuilt," by Texas Instruments, dated 06/24/13.

TEXAS INSTRUMENTS
Santa Clara, California

INTERIOR FLOOR PLAN AND AIR HANDLING AREAS WITH PROPOSED SAMPLE LOCATIONS - BUILDING W-1

Date 03/03/14	Project No. 750620701	Figure 14

LANGAN TREADWELL ROLLO

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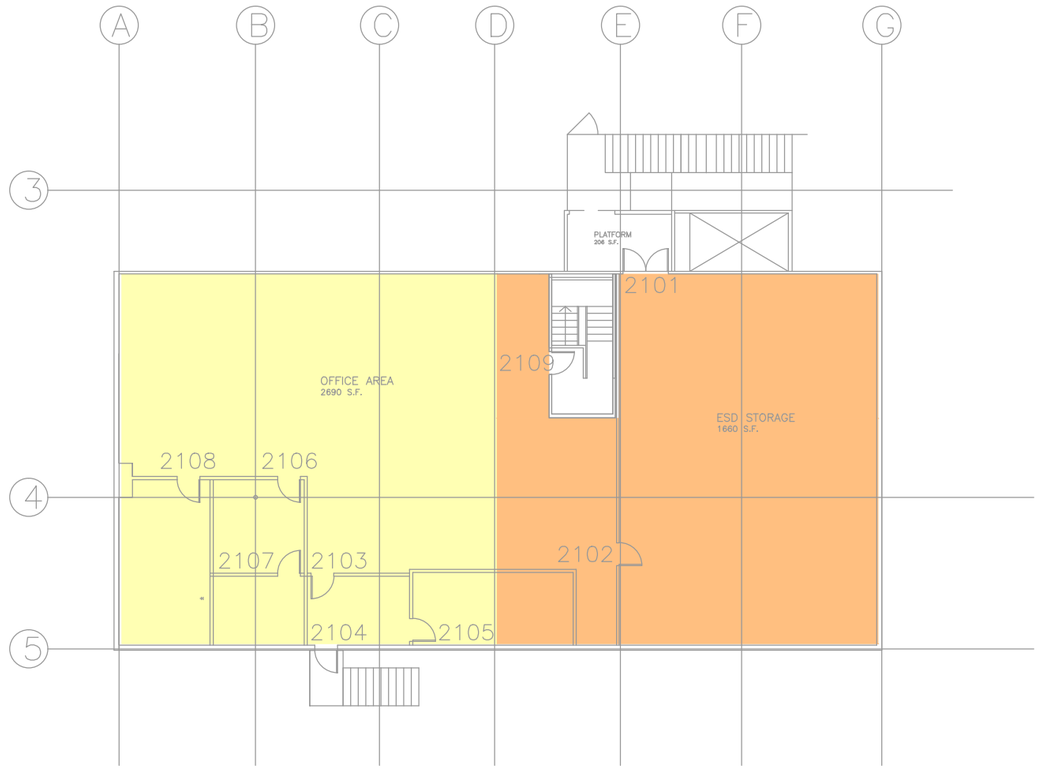

EXPLANATION

Air Conditioning 1

Air Conditioning 2

1. No sampling is proposed at Building W, Floor 2, because the space is unoccupied.

0 20 Feet

Approximate scale

Reference: Base map from a drawing titled, "Building W-2 AsBuilt," by Texas Instruments, dated 06/24/13.

TEXAS INSTRUMENTS
Santa Clara, California

INTERIOR FLOOR PLAN AND AIR HANDLING AREAS - BUILDING W-2

Date 02/24/14	Project No. 750620701	Figure 15

LANGAN TREADWELL ROLLO

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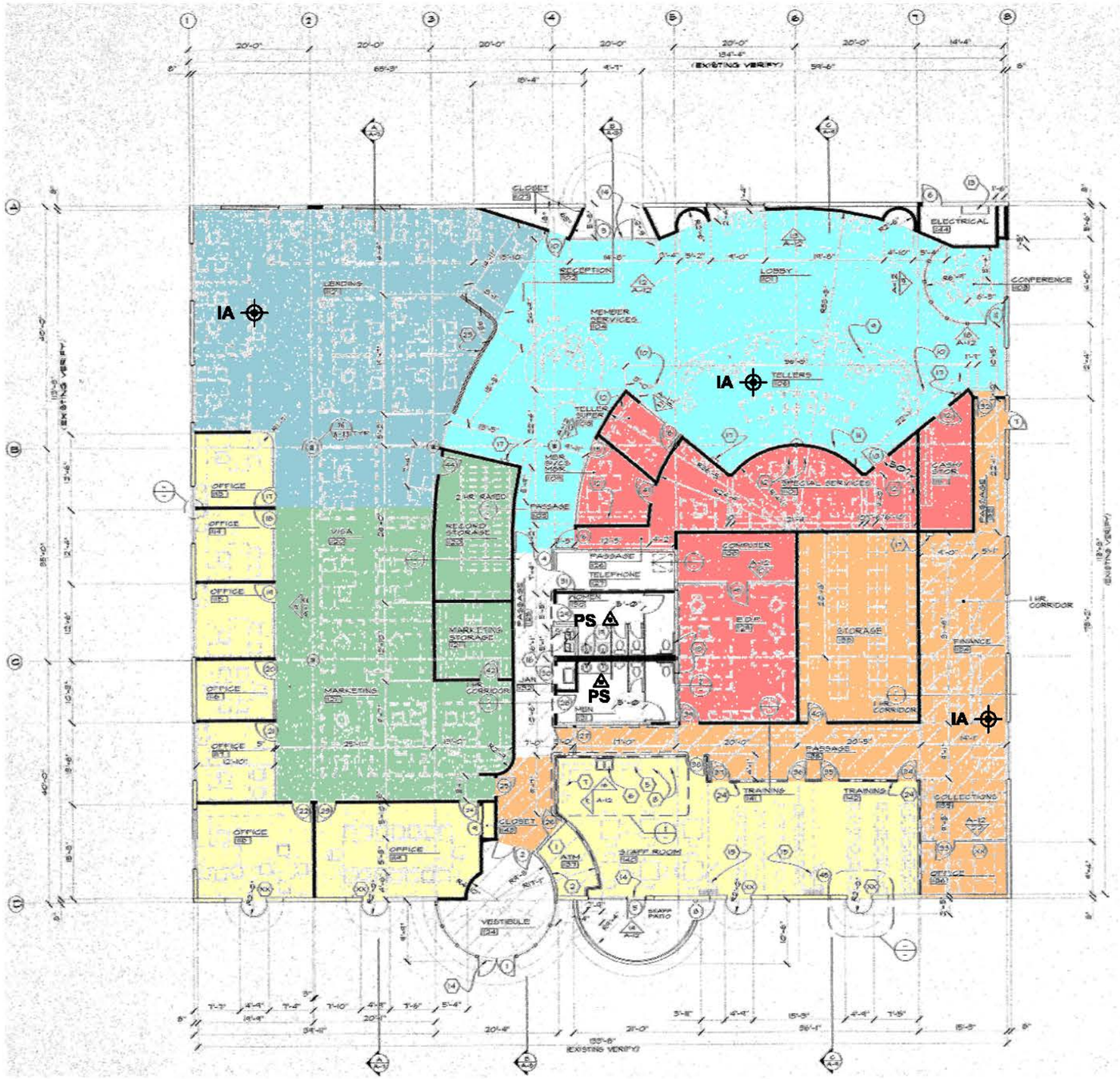

EXPLANATION

- Air Conditioning 1
- Air Conditioning 2
- Air Conditioning 3
- Air Conditioning 4
- Air Conditioning 5
- Air Conditioning 6
- IA — Proposed indoor air sample
- PS — Proposed pathway sample

Note: Indoor and pathway air sample locations were previously approved by the EPA and Water Board following building surveys. These locations were previously sampled in the winter of 2012/2013. These locations are proposed for re-testing in 2014.

0 20 Feet

Approximate scale

Reference: Base map from a drawing titled, "National Semiconductor Federal Credit Union," by Facility Design Group, dated 06/22/00.

TEXAS INSTRUMENTS
Santa Clara, California

INTERIOR FLOOR PLAN AND AIR HANDLING AREAS WITH PROPOSED SAMPLE LOCATIONS - BUILDING 39

Date 02/24/14 | Project No. 750620701 | Figure 16

LANGAN TREADWELL ROLLO

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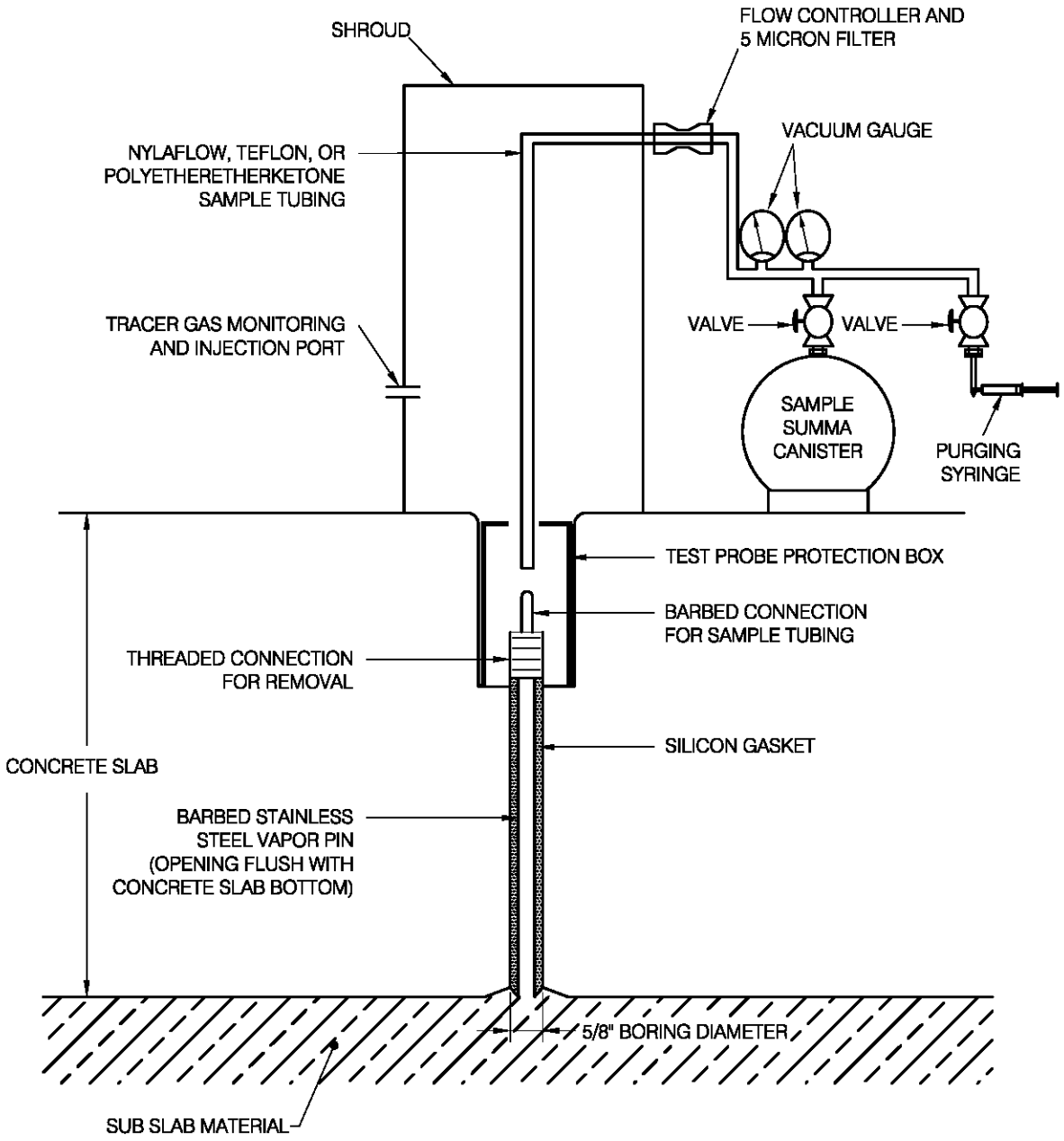


(NOT TO SCALE)

TEXAS INSTRUMENTS
Santa Clara, California

SUB-SLAB SOIL VAPOR SAMPLING SETUP

LANGAN TREADWELL ROLLO

Date 02/24/14	Project No. 750620701	Figure 17

APPENDIX A

INDOOR AIR BUILDING SURVEY AND SAMPLING FORM

Indoor Air Building Survey and Sampling Form

Preparer's name: Elma Fung Date: 2/19/2014

Preparer's affiliation: ESH manager Santa Clara Phone #: (669) 721-3885

Site Name: Texas Instruments, Inc. Building #: A

PART I – OCCUPANTS

Building Address: 2900 Semiconductor Drive Santa Clara CA 95051

Property Contact: Jim Greene Owner/Renter/Other: Owner

Contact's Phone: home ( ) work: (669) 721-3335 Cell: (520) 940-4135

# of Building occupants: Children under age 13: 0 Children age 13-18: 0 Adults: ~200

PART II – BUILDING CHARACTERISTICS

Building use: residential / multi-family residential / (office) / strip mall / commercial / industrial

Business Type: OFFICE and LABS

Describe building: Two story Year constructed: 1970

Sensitive population: day care / nursing home / hospital / school / other (specify): NA

Multiple Units? Yes/(No) Number of Units: NA

Number of floors below grade: 0 (full basement / crawl space / slab on grade) Height of each floor (ft.) _

Number of floors at or above grade: 2 Height of each floor (ft.) 9-10 ft to grid

Depth of basement below grade surface: ____ ft. Basement size: _____ ft² Basement Slab thickness: ___inch

Basement Condition: wet dry damp moldy

Finished unfinished partially finished

Basement floor construction: concrete / dirt / floating / stone / other (specify): N/A

Concrete floor: Unsealed/sealed with: some lab areas has epoxy sealant/coating

Are the basement walls or floor sealed with water proof paint or epoxy coatings? Yes / No N/A

Foundation walls: (Poured concrete) / cinder blocks / stone / other (specify): _____

Basement sump present? Yes / No Sump pump? Yes / NoWater in sump?Yes / No N/A

Sump construction: (Poured concrete) / cinder blocks / stone / other (specify)): _____

Elevator Present (Yes) / No) # of Elevators: 2

Elevator Shaft details: depth below grade (ft.) ~ 4-5 feet

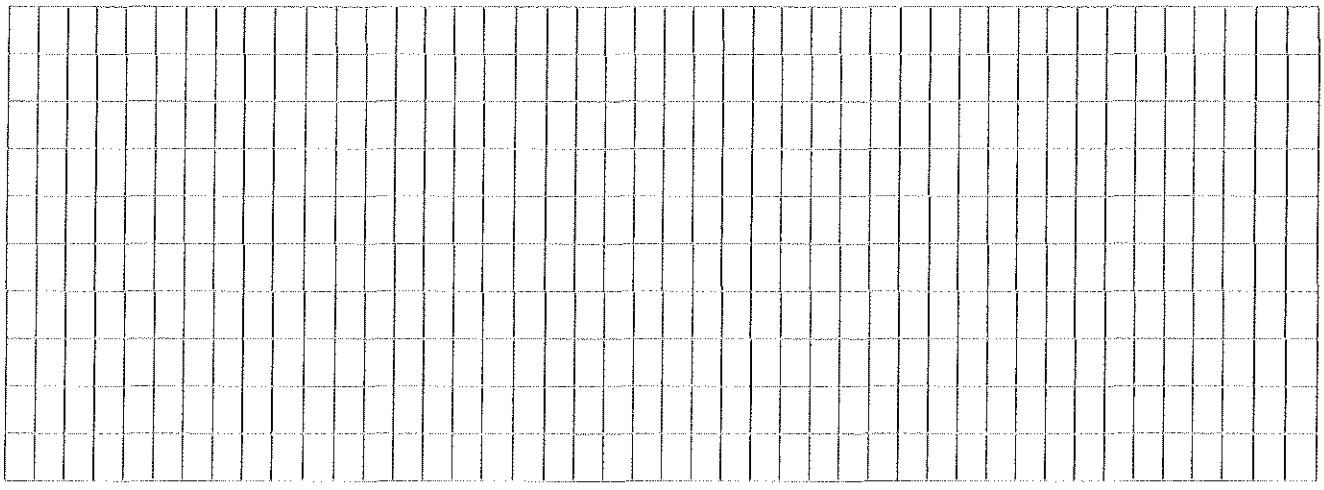
Shaft bottom construction: (Poured concrete) / cinder blocks / stone / other (specify): _____

Identify potential vapor entry points and approximate size (cracks, utility point, drains)

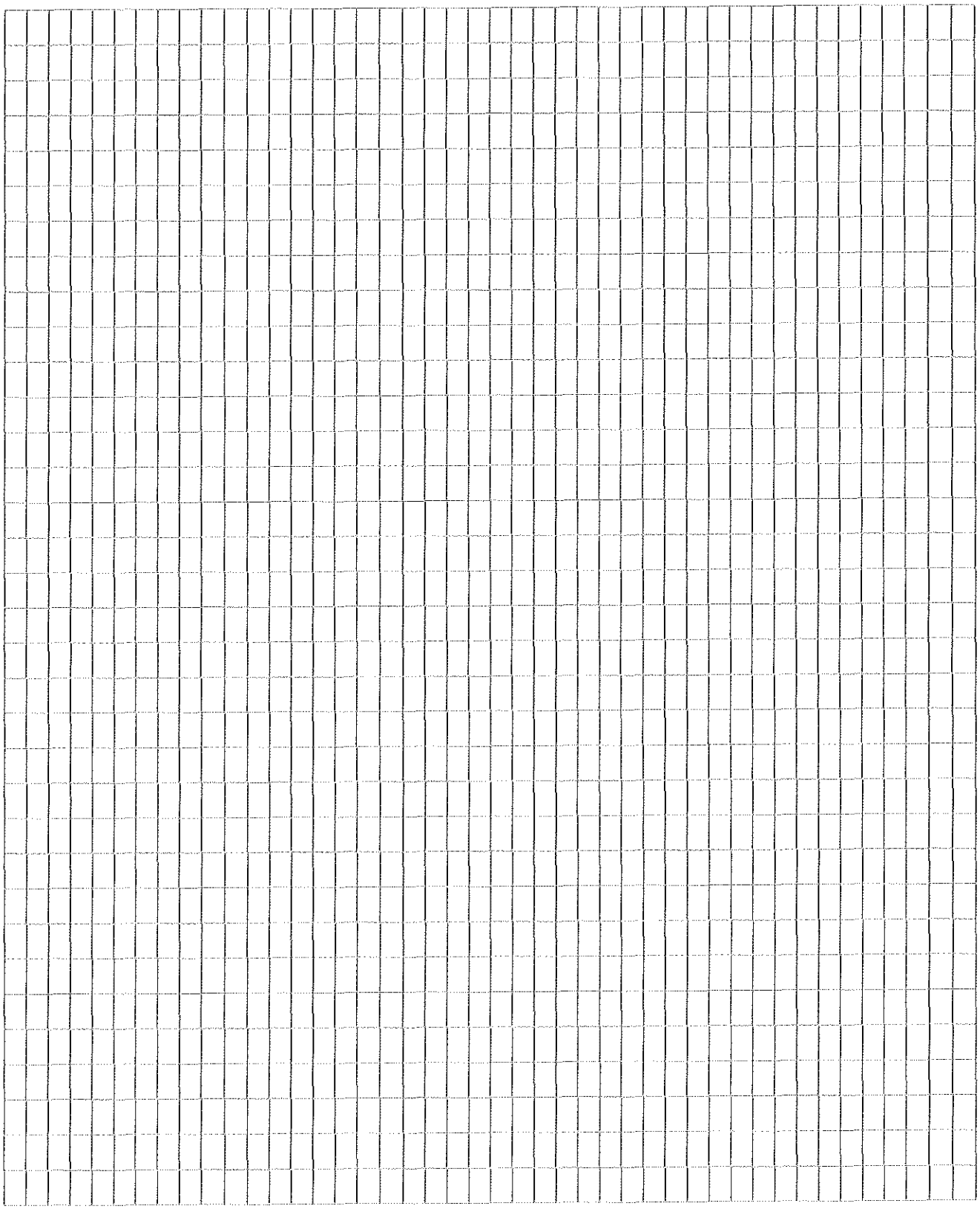
FLOOR PLANS

Attach or draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PId meter readings. If the building does not have a basement, please note:

Basement:



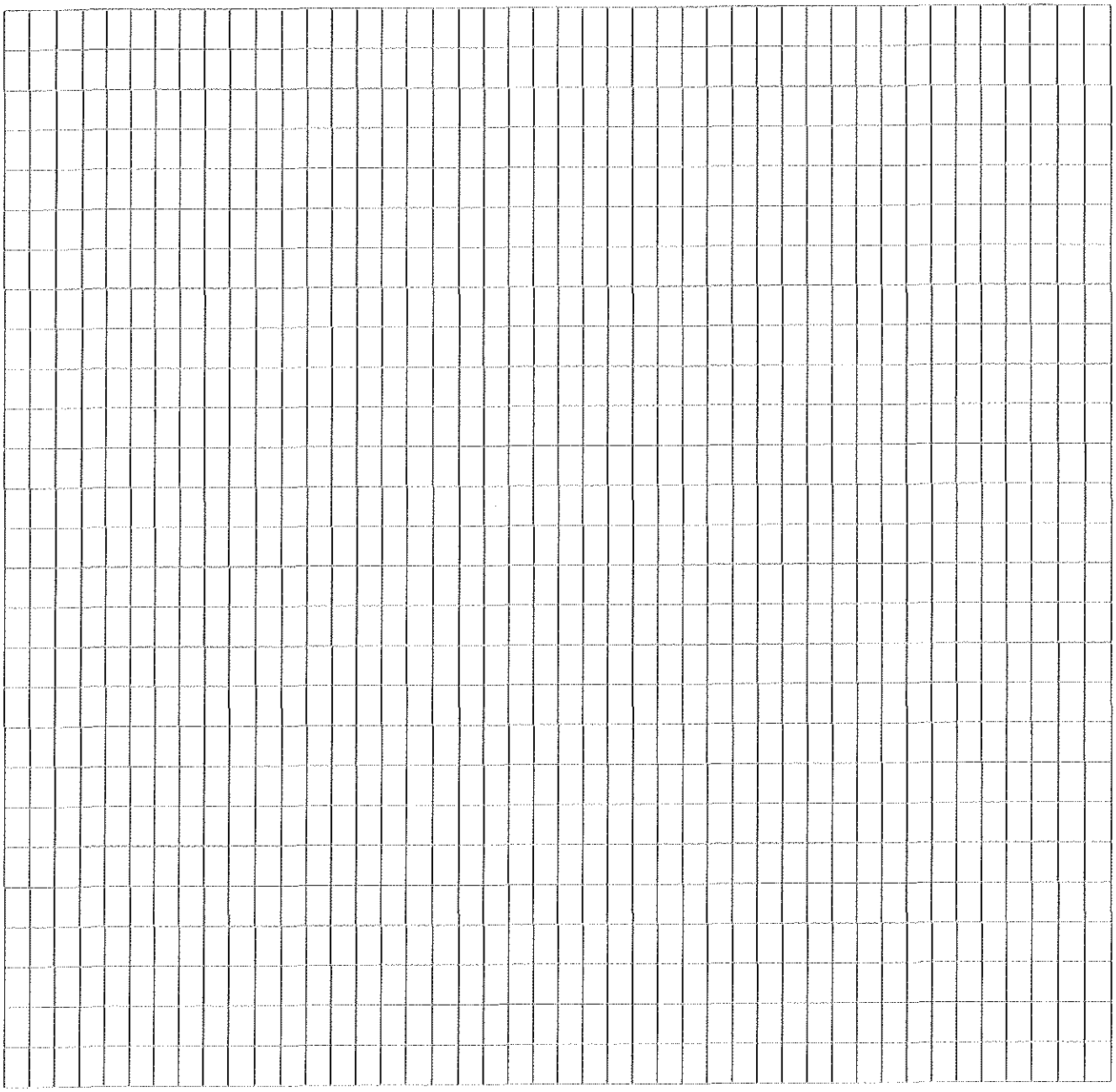
Firs Floor:

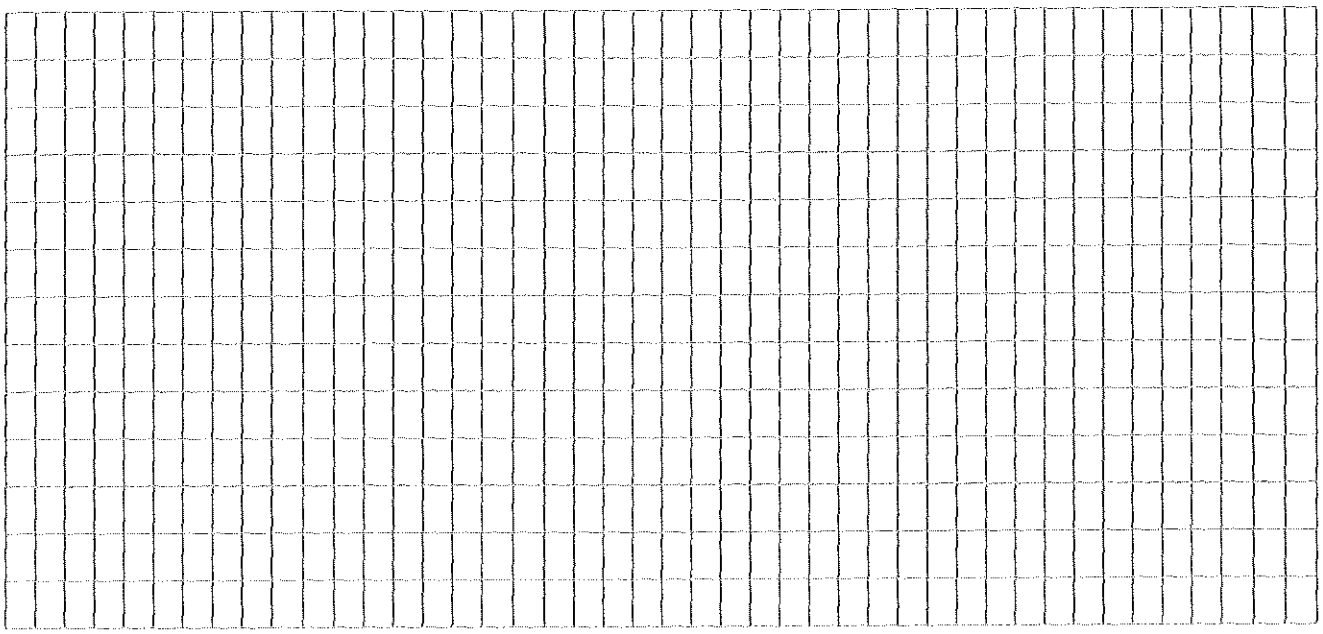


Outdoor Plot

Attach or draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.





PART III – HVAC CHARACTERISTICS

Type of heating system (circle all that apply):

Hot air circulation hot air radiation wood steam radiation

Heat pump (hot water radiation) kerosene heater electric baseboard

Other (specify): _____

Type of ventilation system (circle all that apply):

(Central air conditioning) (mechanical fans) (bathroom ventilation fans)

(Individual air conditioning units) kitchen range hood fan (outside air intake)

Other (specify): _____

Type of fuel utilized (circle all that apply):

(Natural gas) / electric / fuel oil / wood / coal / solar / kerosene

Is there a whole house fan? Yes / No

Water Supply: (Public) Well Other: _____

Septic system? Yes / Yes (but not used) (No)

Water Heater Fueled by: Natural Gas and electric

Irrigation / private well? Yes / Yes (but not used) / (No)

Type and percent of ground cover outside of building: grass / concrete / asphalt / other (specify) ~20% grass ~80% concrete/asphalt

Existing subsurface depressurization (radon) system in place? Yes / (No) active / passive

Sub-slab vapor / moisture barrier in place? Yes / (No)

Type of barrier: _____

Air Handling Unit

Unit identification 4 [HVAC 4, HVAC 11, HVAC 5, HVAC 6] Area served: Office & Labs

Outdoor Air Intake, Mixing Plenum, and Damper

Outdoor air intake location: Roof (HVAC 4,5,6) Ground level (HVAC 11)

Nearby contaminant sources? (describe): _____

Bird screen in place and unobstructed? Yes

Design total cfm _____ Outdoor air (O.A.) cfm 10% of Total CFM Date last tested and balanced: PM every 6 mos.

Minimum % O.A. (damper setting) 10% for HVAC 11 100% Minimum cft O.A. (total cfm x minimum %O.A.)/100 = _____

Current O.A. damper setting (date, time, and HVAC operating mode): 10% ~ HVAC 5, 4, 11 24 hours HVAC 6 4am-6pm

Damper control sequence (describe): dependent on outside air temp

Condition of dampers and controls (note date): good condition → HVAC 11 no fixed damper

Fans

Control sequence: control by static pressure

Condition (note date): good condition

Indicated temperatures Supply air: ~55F mixed air: ~70F return air: ~72F outdoor air: _____

Actual temperatures Supply air: ~55F mixed air: ~70F return air: ~72F outdoor air: _____

* HVAC 11 no Damper - 100% outside air

Coils

Heating fluid discharge temperature: 100F ΔT: 20F cooling fluid discharge temperate 45F ΔT: 20F

Controls (describe): _____

Condition (note date): _____

Humidifier

Type: N/A if biocide is used, note type: _____

Condition (no overflow, drains trapped, all nozzles working?): _____

No slime, visible growth, or mineral deposits? _____

Boilers

Rated Btu input ~1 million Condition: good

Combustion air: is there at least one square inch free area per 2,000 Btu input? NO

Fuel or combustion odors: none

Cooling Tower

Clean? No leaks or overflow: Yes clean Slime or algae growth? none

Eliminator performance: good

Biocide treatment working (list type of biocide): Garratt 2128, Yes

Spill containment plan implemented? NA Dirt separator working? Yes

Chillers

Refrigerant leaks? none

Evidence of condensation problems? none

Waste oil and refrigerant properly stored and disposed of? yes

Distribution System

		Supply Air		Return Air		Power Exhaust		
Zone/ Room	System Type	Ducted/ unducted	Cfm*	Ducted/ unducted	cftm*	cfm*	Control	Serves (e.g. toilet)

Condition of distribution system and terminal equipment (note locations of problems)

Adequate access for maintenance? yes

Ducts and coils clean and obstructed? PM every 6 mos.

Air paths unobstructed? Supply ✓ return: ✓ transfer: ✓ exhaust: make-up: ✓

Note locations of blocked air paths, diffusers, or grilles:

Any unintentional openings into plenums? no

Controls operating properly? yes

Filters

Location	Type/Rating	Size	Date last Changed	Condition (give date)
HVAC 4,5,6 Roof		~varies in size ~2-4 in thick	will be changed/y every 2 years	good
HVAC 11		24x24x2	will be changed 2014	good

Occupied Space

Thermostat Types: Siemens Thermostat (various locations)

Zone Room	Thermostat Location	What does Thermostat Control? (e.g. radiator, AHU-3)	Setpoints		Measured Temperature	Day/Time
			Summer	Winter		

Humidistats/Dehumidistats type: only on Test floor siemens

Zone/Room	Humidistat/ Dehumidistat Location	What Does it Control?	Setpoints (%RH)	Measured Temperature	Day/Time

Potential problems (note location): _____

Thermal comfort or air circulation (drafts, obstructed airflow, stagnant air, overcrowding, poor thermostat location):

_____

_____

Malfunctioning equipment: _____

Major sources of odors of contaminants (e.g., poor sanitation, incompatible uses of space)

_____

Are there air distribution ducts present? Yes/No

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the location on the floor plan diagram.

_____

_____

_____

_____

_____

Part IV – Occupancy

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

Level	General Use of Each Floor (e.g. family room, bedroom, laundry, workshop, storage)
Basement	no basement
1st Floor	lab spaces - occasionally occupied
2nd floor	office and labs - fully occupied
3rd floor	
4th floor	

Factors that May Influence Indoor Air Quality

a. Is there an attached garage? Y /(N)

b. Does the garage have a separate heating unit? Y/ N/(NA)

c. Area petroleum-powered machines or vehicles stored in the garage (e.g. lawnmower, atv, car) Y/ N/(NA) Please specify _____

d. Has the building ever had a fire? Y /(N) When? _____

e. Is a kerosene or unvented gas space heater present? Y /(N) Where? _____

f. Is there a workshop or hobby/craft area? Y /(N) Where & Type? _____

g. Is there smoking in the building? Y /(N) How frequently? _____

h. Have cleaning products been used recently? Y / (N) When & Type?

i. Have cosmetic products been used recently? Y /(N) When & Type? _____

j. Has painting/staining been done in the last 6 months? Y /(N) Where & When? _____

k. Is there new carpet, drapes or other textiles? Y /(N) Where & When? _____

l. Have air fresheners been used recently? Y /(N) When & Type? _____

m. Is there a kitchen exhaust fan? Y / N If yes, where vented? break room exhaust

n. Is there a bathroom exhaust fant? (Y) / N If yes, where vented? _____

o. Is there a clothes dryer? Y /(N) If yes, is it vented outside? Y/N

p. Has there been a pesticide application? Y /(N) When & Type? _____

Are there odors in the building? Y /(N)

If yes, please describe: _____

Do any of the building occupants use solvents at work? (Y) / N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)

If yes, what types of solvents are used? IPA, Acetone

If yes, are there clothes washed at work? Y / (N)

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly) No
Yes, use dry-cleaning infrequently (monthly or less) (Unknown)
yes, work at a dry-cleaning service

Is there a radon mitigation system for the building/structure? Y (N) Date of Installation: _____

Is the system active or passive? Active/Passive N/A

PART V – OUTSIDE CONTAMINANT SOURCES

Known contaminated site (1,000-ft. radius): _____

Other stationary sources nearby (gas stations, emission stacks, etc.): _____

Heavy vehicular traffic nearby (or other mobile sources) and distance from building: _____

PART VI – MISCELLANEOUS ITEMS

Do any occupants of the building smoke? (Yes) / No How often? Unknown

Last time someone smoked in the building? Building campus Tobacco free. Hours / c

Does the building have an attached garage directly connected to living space? Yes / (No)

If so, is a car usually parked in the garage? Yes / No

Are gas-powered equipment or cans of gasoline/fuels stored in the garage? Yes / (No)

Do the occupants of the building have their clothes dry cleaned? (Yes) / No

If yes, how often? Weekly / monthly / 304 times a year

Do any of the occupants use solvents in work? (Yes) / No

If yes, what types of solvents are used? IPA, Acetone

If yes, are their clothes washed work? Yes / (No)

Have any pesticides/herbicides been applied around the building or in the yard? Yes / (No)

If so, when and which chemicals? _____

Has there ever been a fire in the building? Yes / (No) If yes, when? _____

Has painting or staining been done in the building in the last 6 months? Yes / (No)

If yes, when _____ and where? _____

Additional Notes: _____

_____

_____

_____

_____

PART VII – INDOOR CONTAMINANT SOURCES

Identify all potential indoor sources found in the building (including attached garages), the location of the source (floor and room), and whether the item was removed from the building 48 hours prior to indoor air sampling event. Any ventilation implemented after removal of the items should be completed at least 24 hours prior to the commencement of the indoor air sampling event.

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
Gasoline storage cans			
Gas-powered equipment			
Kerosene storage cans			
Paints / thinners / strippers			
Cleaning solvents		Janitor closet	
Oven cleaners			
Carpet / upholstery			

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
cleaners			
Other house cleaning products		Yes	
Moth balls			
Polishes / waxes		Yes	
Insecticides		Yes	
Furniture / floor polish			
Nail polish / polish remover		Yes	
Hairspray		Yes	
Cologne / perfume		Yes	
Air fresheners			
Fuel tank (inside building)			
Wood stove or fireplace			
New furniture / upholstery			
New carpeting / flooring			
Hobbies – glues, paints, etc.			

Additional Notes: _____

_____

Indoor Air Building Survey and Sampling Form

Preparer's name: Elma Fung Date: 2/19/14

Preparer's affiliation: ESH manager Santa Clara Phone #: (669) 721 3885

Site Name: Texas Instruments, Inc. Building #: B

PART I – OCCUPANTS

Building Address: 2900 Semiconductor Dr. Santa Clara CA 95051

Property Contact: Jim Greene (Owner)/Renter/Other: _____

Contact's Phone: home ( ) _____ work: (669) 721 3335 Cell: (520) 940 - 4135

# of Building occupants: Children under age 13: 0 Children age 13-18: 0 Adults: 15

PART II – BUILDING CHARACTERISTICS

Building use: residential / multi-family residential / office / strip mall / (commercial) / industrial

Business Type: Cafeteria

Describe building: one story Year constructed: 1972

_____

Sensitive population: day care / nursing home / hospital / school / other (specify): _____

Multiple Units? Yes/(No) Number of Units: _____

Number of floors below grade: 0 (full basement / crawl space / slab on grade) Height of each floor (ft.) _

Number of floors at or above grade: 1 Height of each floor (ft.) 9-10 ft to ceiling grid

Depth of basement below grade surface: ____ ft. Basement size: _____ ft² Basement Slab thickness: ___inch

Basement Condition: wet dry damp moldy

Finished unfinished partially finished

Basement floor construction: concrete / dirt / floating / stone / other (specify): N/A

Concrete floor: Unsealed/sealed with: _____

Are the basement walls or floor sealed with water proof paint or epoxy coatings? Yes / No N/A

Foundation walls: Poured concrete / cinder blocks / stone / other (specify): _____

Basement sump present? Yes / No Sump pump? Yes / NoWater in sump?Yes / No N/A

Sump construction: Poured concrete / cinder blocks / stone / other (specify)): _____

Elevator Present (Yes / No) # of Elevators: _____

Elevator Shaft details: depth below grade (ft.) _____

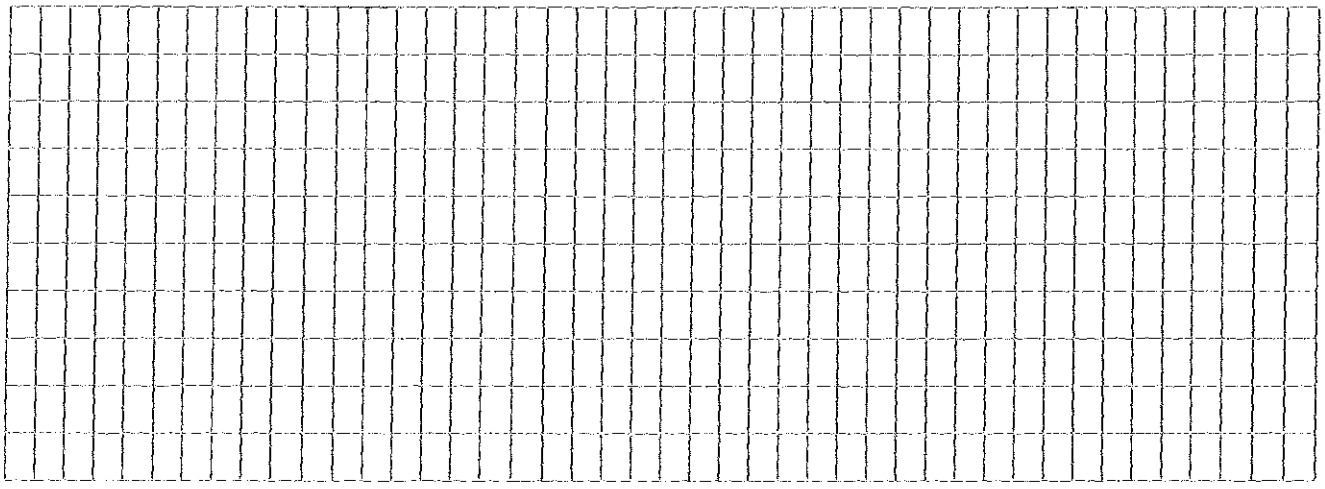
Shaft bottom construction: Poured concrete / cinder blocks / stone / other (specify): _____

Identify potential vapor entry points and approximate size (cracks, utility point, drains)

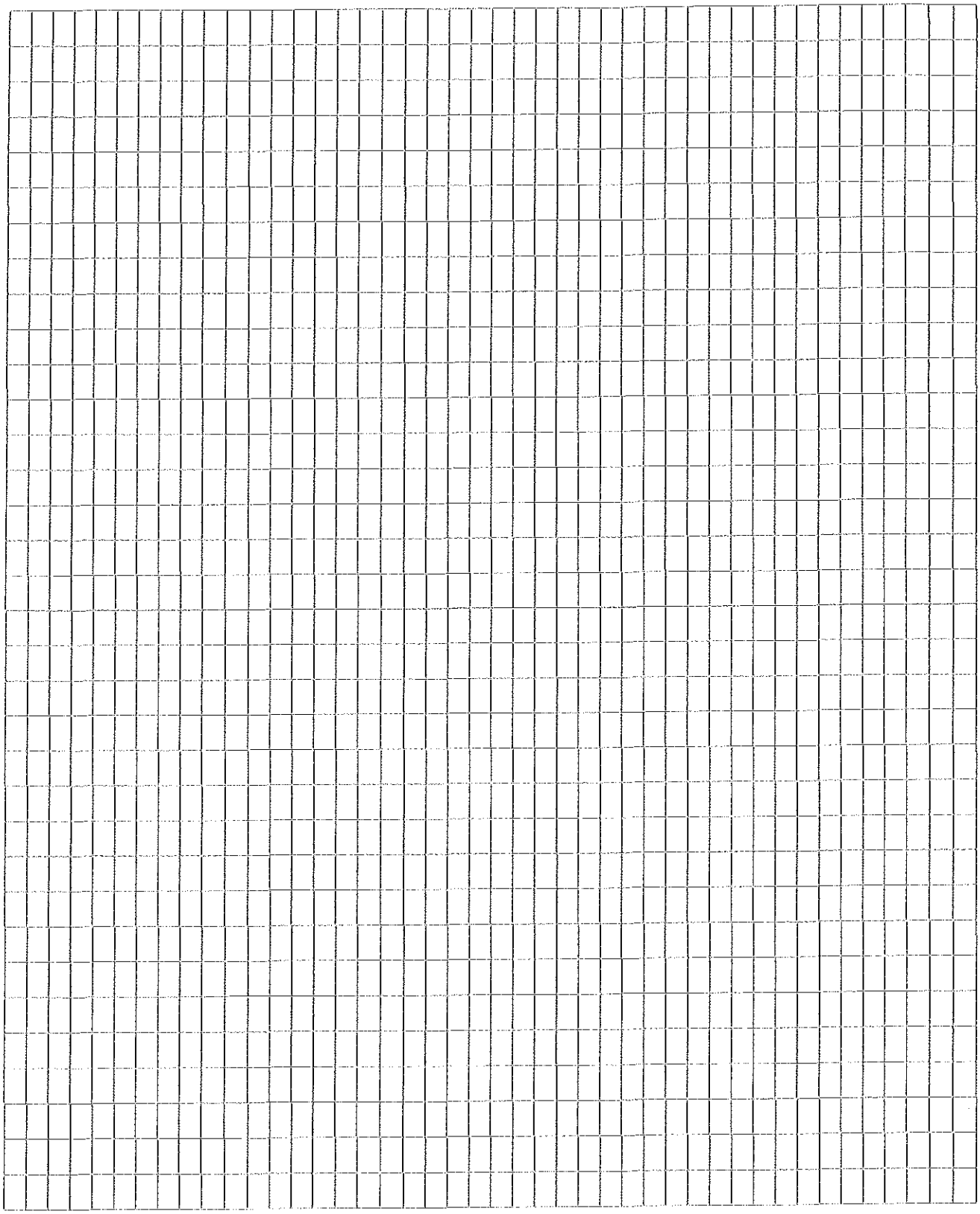
FLOOR PLANS

Attach or draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PId meter readings. If the building does not have a basement, please note:

Basement:



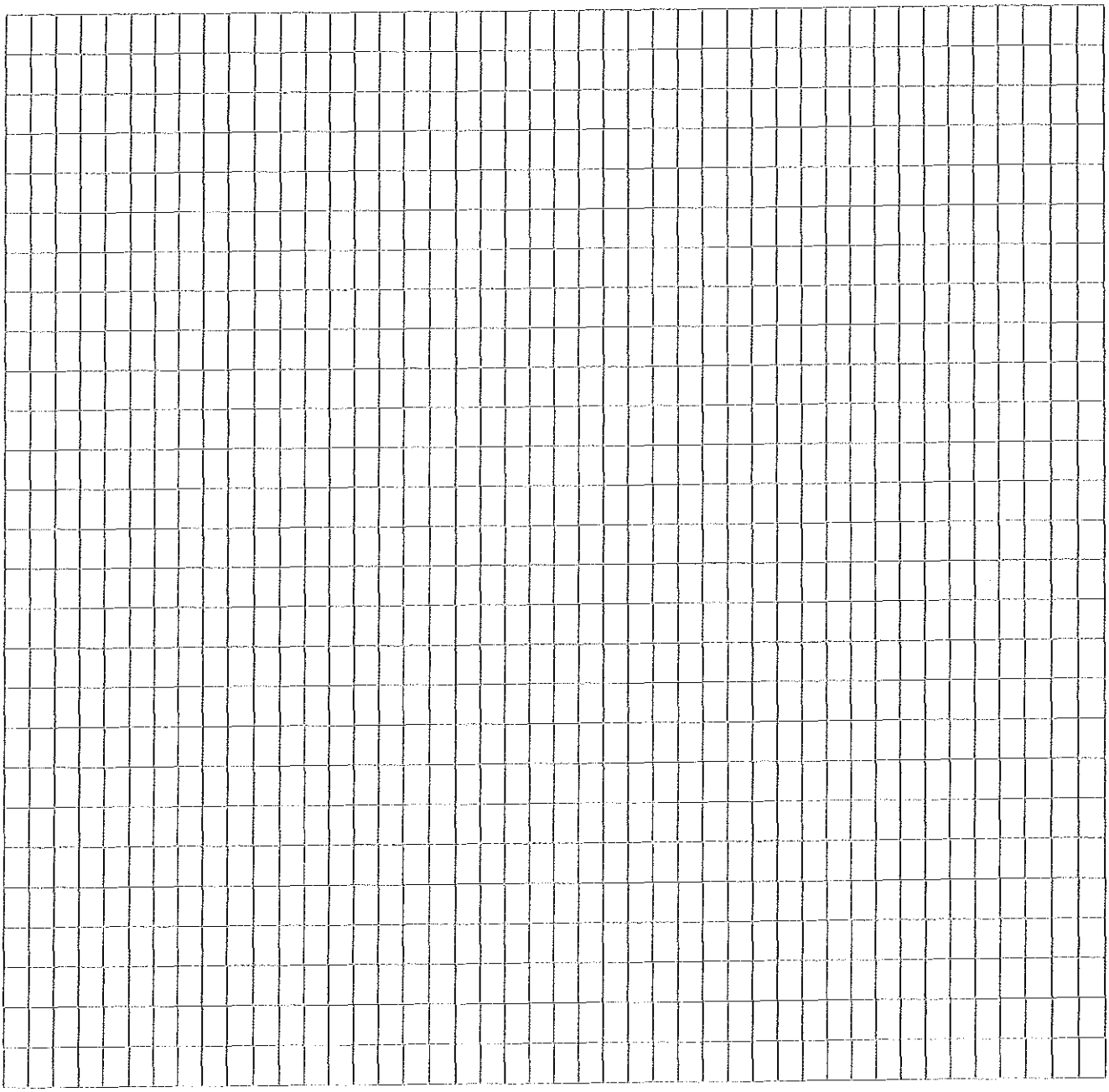
Firs Floor:

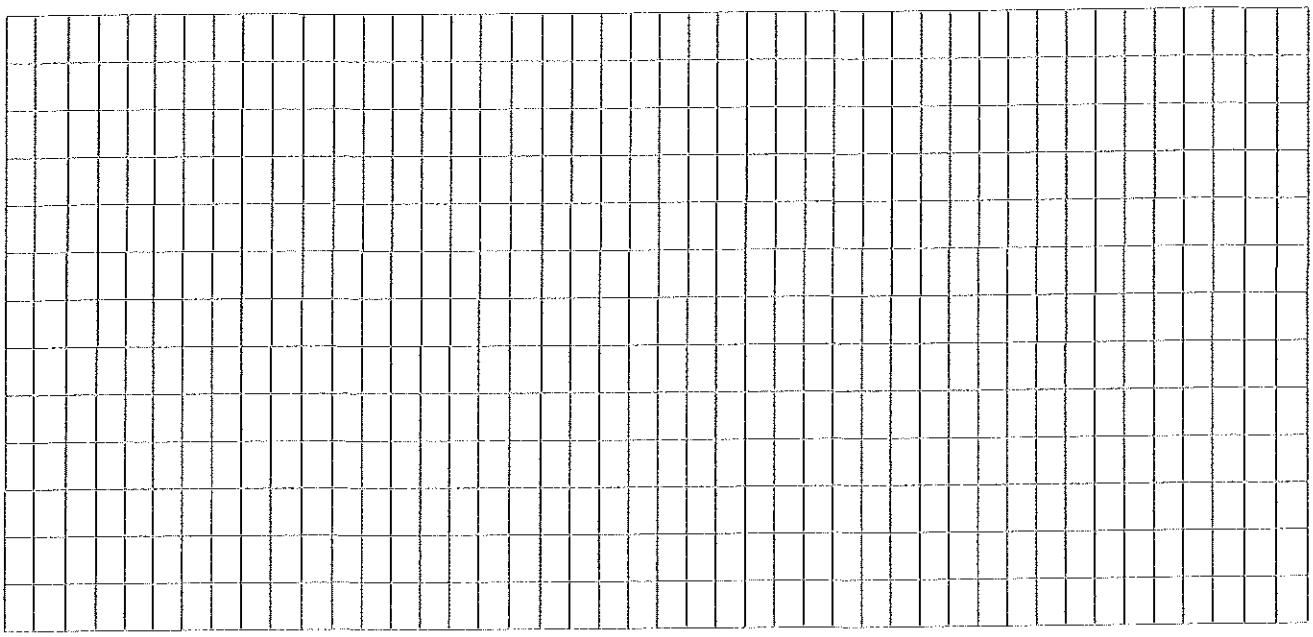


Outdoor Plot

Attach or draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.





PART III – HVAC CHARACTERISTICS

Type of heating system (circle all that apply):

Hot air circulation hot air radiation wood steam radiation

Heat pump (hot water radiation) kerosene heater electric baseboard

Other (specify): _____

Type of ventilation system (circle all that apply):

(Central air conditioning) (mechanical fans) (bathroom ventilation fans)

(Individual air conditioning units) (kitchen range hood fan) (outside air intake)

Other (specify): _____

Type of fuel utilized (circle all that apply):

(Natural gas) / (electric) / fuel oil / wood / coal / solar / kerosene

Is there a whole house fan? Yes / (No)

Water Supply: (Public) Well Other: _____

Septic system? Yes / Yes (but not used) / (No)

Water Heater Fueled by: natural gas and electric

Irrigation / private well? Yes / Yes (but not used) / (No)

Type and percent of ground cover outside of building: grass / concrete / asphalt / other (specify) 100% concrete

Existing subsurface depressurization (radon) system in place? Yes / (No) active / passive

Sub-slab vapor / moisture barrier in place? Yes / (No)

Type of barrier: _____

Air Handling Unit

Unit identification HVAC 1, 2 Area served: kitchen, cafeteria

Outdoor Air Intake, Mixing Plenum, and Damper

Outdoor air intake location: roof

Nearby contaminant sources? (describe): _____

Bird screen in place and unobstructed? yes

Design total cfm _____ Outdoor air (O.A.) cfm 10% Date last tested and balanced: _____

Minimum % O.A. (damper setting) 10% Minimum cft O.A. (total cfm x minimum %O.A.)/100 = _____

Current O.A. damper setting (date, time, and HVAC operating mode): min. 10%

Damper control sequence (describe): controlled by return temp & outside temp

Condition of dampers and controls (note date): good

Fans

Control sequence: controlled by HVAC 1

Condition (note date): good

Indicated temperatures Supply air: ~55F mixed air: ~65F return air: ~72F outdoor air: _____

Actual temperatures Supply air: ~55F mixed air: ~65F return air: ~72F outdoor air: _____

Coils

Heating fluid discharge temperature: ~110F ΔT: 20F cooling fluid discharge temperate ~44F ΔT: 20F

Controls (describe): Temp control

Condition (note date): good

Humidifier

Type: none if biocide is used, note type: _____

Condition (no overflow, drains trapped, all nozzles working?): _____

No slime, visible growth, or mineral deposits? _____

Boilers

Rated Btu input none Condition: _____

Combustion air: is there at least one square inch free area per 2,000 Btu input? _____

Fuel or combustion odors: _____

Cooling Tower

Clean? No leaks or overflow: none Slime or algae growth? _____

Eliminator performance: _____

Biocide treatment working (list type of biocide): _____

Spill containment plan implemented? _____ Dirt separator working? _____

Chillers

Refrigerant leaks? none

Evidence of condensation problems? none

Waste oil and refrigerant properly stored and disposed of? yes

Distribution System

		Supply Air		Return Air		Power Exhaust		
Zone/ Room	System Type	Ducted/ unducted	Cfm*	Ducted/ unducted	cftm*	cfm*	Control	Serves (e.g. toilet)

Condition of distribution system and terminal equipment (note locations of problems)

Adequate access for maintenance? yes

Ducts and coils clean and obstructed? yes

Air paths unobstructed? Supply ✓ return: ✓ transfer: ✓ exhaust: make-up: ✓

Note locations of blocked air paths, diffusers, or grilles: roof

Any unintentional openings into plenums? none

Controls operating properly? yes

Filters

Location	Type/Rating	Size	Date last Changed	Condition (give date)
on the HVAC				
unit				

Occupied Space

Thermostat Types: Siemens

Zone Room	Thermostat Location	What does Thermostat Control? (e.g. radiator, AHU-3)	Setpoints		Measured Temperature	Day/Time
			Summer	Winter		
Cafe		controls return air	70-74			M-F 10am-3pm
Kitchen		& heat coil				

Humidistats/Dehumidistats type: none

Zone/Room	Humidistat/ Dehumidistat Location	What Does it Control?	Setpoints (%RH)	Measured Temperature	Day/Time

Potential problems (note location): _____

Thermal comfort or air circulation (drafts, obstructed airflow, stagnant air, overcrowding, poor thermostat location):

_____

_____

Malfunctioning equipment: _____

Major sources of odors of contaminants (e.g., poor sanitation, incompatible uses of space)

_____

Are there air distribution ducts present? Yes/No

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the location on the floor plan diagram.

_____

_____

_____

_____

_____

Part IV – Occupancy

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

Level	General Use of Each Floor (e.g. family room, bedroom, laundry, workshop, storage)
Basement	none
1st Floor	Occasionally (7am - 230pm)
2nd floor	
3rd floor	
4th floor	

Factors that May Influence Indoor Air Quality

a. Is there an attached garage? Y /(N)

b. Does the garage have a separate heating unit? Y/ N/ (NA)

c. Area petroleum-powered machines or vehicles stored in the garage (e.g. lawnmower, atv, car) Y/ N/ (NA) Please specify _____

d. Has the building ever had a fire? Y /(N) When? _____

e. Is a kerosene or unvented gas space heater present? Y / (N) Where? _____

f. Is there a workshop or hobby/craft area? Y / (N) Where & Type? _____

g. Is there smoking in the building? Y / (N) How frequently? _____

h. Have cleaning products been used recently? (Y)/ N When & Type?

i. Have cosmetic products been used recently? Y / (N) When & Type? _____

j. Has painting/staining been done in the last 6 months? Y / (N) Where & When? _____

k. Is there new carpet, drapes or other textiles? Y / (N) Where & When? _____

l. Have air fresheners been used recently? Y / (N) When & Type? _____

m. Is there a kitchen exhaust fan? (Y)/ N If yes, where vented? _____

n. Is there a bathroom exhaust fant? (Y)/ N If yes, where vented? _____

o. Is there a clothes dryer? Y / (N) If yes, is it vented outside? Y/N

p. Has there been a pesticide application? Y /(N) When & Type? _____

Are there odors in the building? Y /(N)

If yes, please describe: _____

Do any of the building occupants use solvents at work? Y / (N)

(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)

If yes, what types of solvents are used? _____

If yes, are there clothes washed at work? Y / (N)

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly) No
Yes, use dry-cleaning infrequently (monthly or less) Unknown
yes, work at a dry-cleaning service

Is there a radon mitigation system for the building/structure? Y (N) Date of Installation: _____

Is the system active or passive? Active/Passive N/A

PART V – OUTSIDE CONTAMINANT SOURCES

Known contaminated site (1,000-ft. radius): _____

Other stationary sources nearby (gas stations, emission stacks, etc.): _____

Heavy vehicular traffic nearby (or other mobile sources) and distance from building: _____

PART VI – MISCELLANEOUS ITEMS

Do any occupants of the building smoke? (Yes) No How often? unknown

Last time someone smoked in the building? N/A Hours / c

Does the building have an attached garage directly connected to living space? Yes / No

If so, is a car usually parked in the garage? Yes / (No)

Are gas-powered equipment or cans of gasoline/fuels stored in the garage? Yes / No

Do the occupants of the building have their clothes dry cleaned? (Yes) / No

If yes, how often? Weekly / monthly / 304 times a year unknown

Do any of the occupants use solvents in work? (Yes) / No

If yes, what types of solvents are used? alcohol

If yes, are their clothes washed work? Yes / (No)

Have any pesticides/herbicides been applied around the building or in the yard? Yes / (No)

If so, when and which chemicals? _____

Has there ever been a fire in the building? Yes / (No) If yes, when? _____

Has painting or staining been done in the building in the last 6 months? Yes / (No)

If yes, when _____ and where? _____

Additional Notes: _____

_____

_____

_____

_____

PART VII – INDOOR CONTAMINANT SOURCES

Identify all potential indoor sources found in the building (including attached garages), the location of the source (floor and room), and whether the item was removed from the building 48 hours prior to indoor air sampling event. Any ventilation implemented after removal of the items should be completed at least 24 hours prior to the commencement of the indoor air sampling event.

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
Gasoline storage cans	✓		
Gas-powered equipment			
Kerosene storage cans			
Paints / thinners / strippers			
Cleaning solvents			
Oven cleaners	✓		
Carpet / upholstery	✓		

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
cleaners			
Other house cleaning products	✓		
Moth balls			
Polishes / waxes			
Insecticides	✓		
Furniture / floor polish			
Nail polish / polish remover	✓		
Hairspray	✓		
Cologne / perfume	✓		
Air fresheners	✓		
Fuel tank (inside building)			
Wood stove or fireplace			
New furniture / upholstery			
New carpeting / flooring			
Hobbies – glues, paints, etc.	✓		

Additional Notes: _____

_____

Treadwell&Rollo
A LANGAN COMPANY

5:30-6

Indoor Air Building Survey and Sampling Form

Preparer's name: Elma Furg Date: 11/9/2012

Preparer's affiliation: Environmental Engineer Phone #: (408) 7213885

Site Name: Texas Instruments Building #: C

PART I – OCCUPANTS

Building Address: 3833 Kifer Road Santa Clara CA 95051

Property Contact: Jim Greene Owner/Renter/Other: Owner

Contact's Phone: home ( ) work: (408) 721-3335 Cell: ( )

# of Building occupants: Children under age 13: _____ Children age 13-18: _____ Adults: 450

PART II – BUILDING CHARACTERISTICS

Building use: residential / multi-family residential / office / strip mall / commercial / industrial

Business Type: OFFice & Research/Development

Describe building: 2-Story Year constructed: 1974

Sensitive population: day care / nursing home / hospital / school / other (specify): N/A

Multiple Units? Yes/(No) Number of Units: N/A

Number of floors below grade: 0 (full basement / crawl space / slab on grade) Height of each floor (ft.) ___

Number of floors at or above grade: 2 Height of each floor (ft.) 9ft to grid

Depth of basement below grade surface: _____ ft. Basement size: _____ ft^2 Basement Slab thickness: ___inch

Basement Condition: wet dry damp moldy

Finished unfinished partially finished

Basement floor construction: concrete / dirt / floating / stone / other (specify): N/A

Concrete floor: Unsealed/sealed with: unsealed

Are the basement walls or floor sealed with water proof paint or epoxy coatings? Yes / No N/A

Foundation walls: (Poured concrete) / cinder blocks / stone / other (specify): _____

Basement sump present? Yes / No Sump pump? Yes / No Water in sump? Yes / No

Sump construction: Poured concrete / cinder blocks / stone / other (specify)): _____

Elevator Present (Yes / No) # of Elevators: 1

Elevator Shaft details: depth below grade (ft.) 25ft

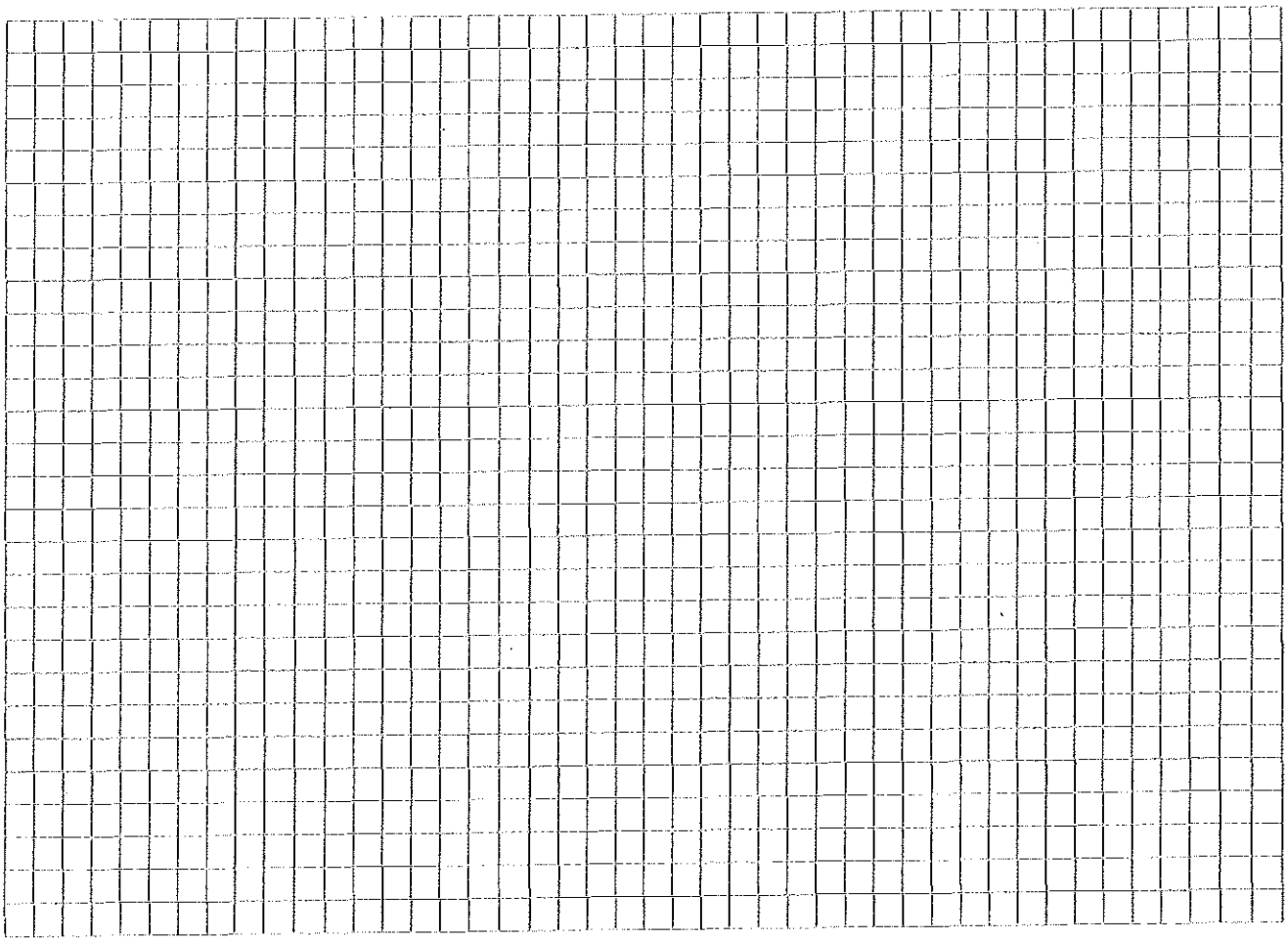
Shaft bottom construction: Poured concrete / cinder blocks / stone / other (specify): _____

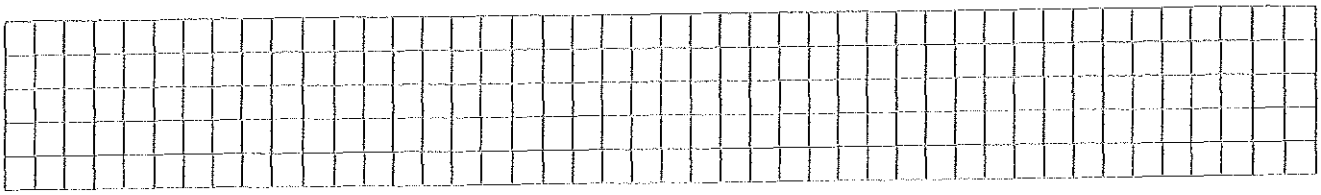
Identify potential vapor entry points and approximate size (cracks, utility point, drains)

FLOOR PLANS

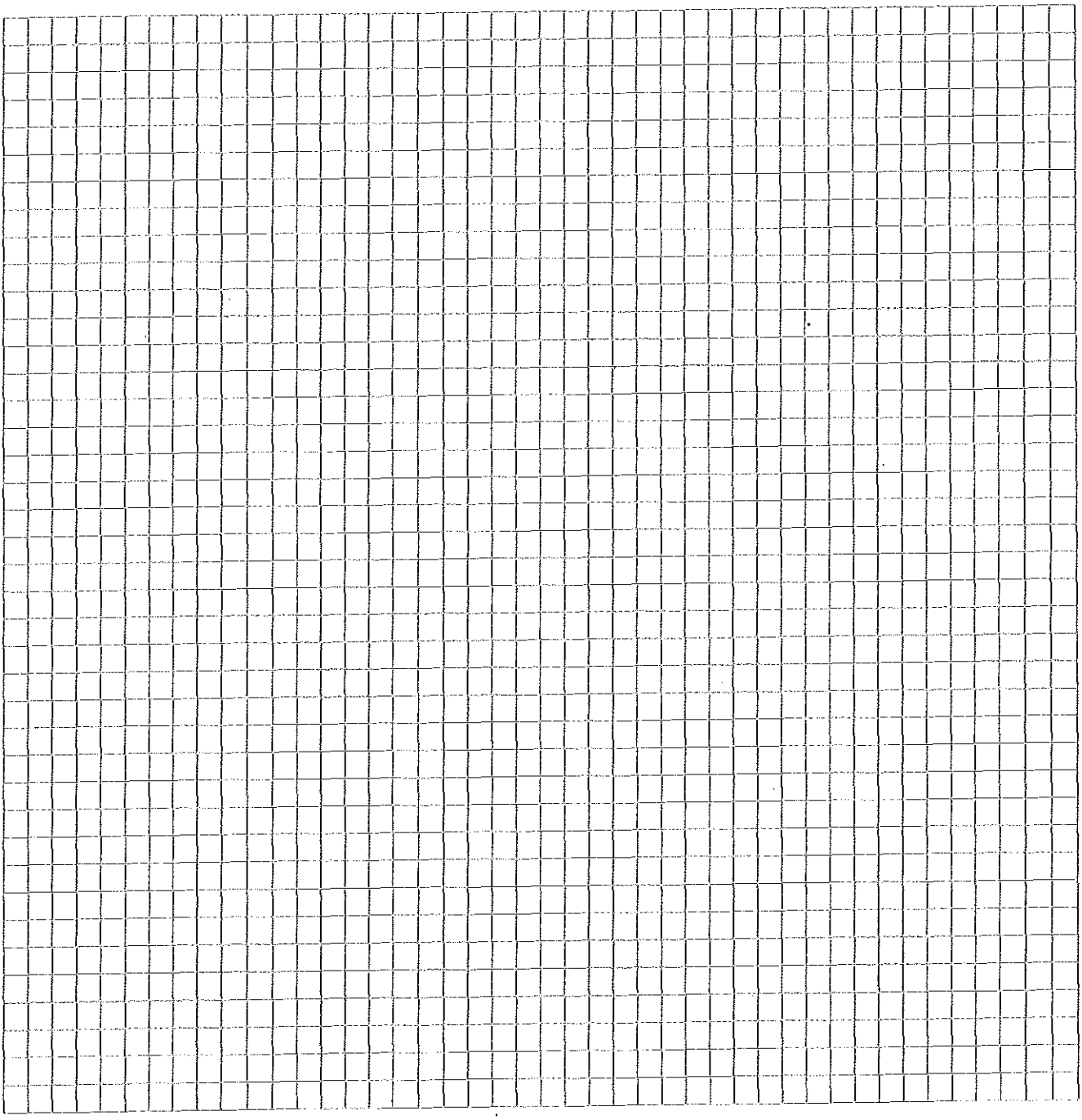
Attach or draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PId meter readings. If the building does not have a basement, please note:

Basement:





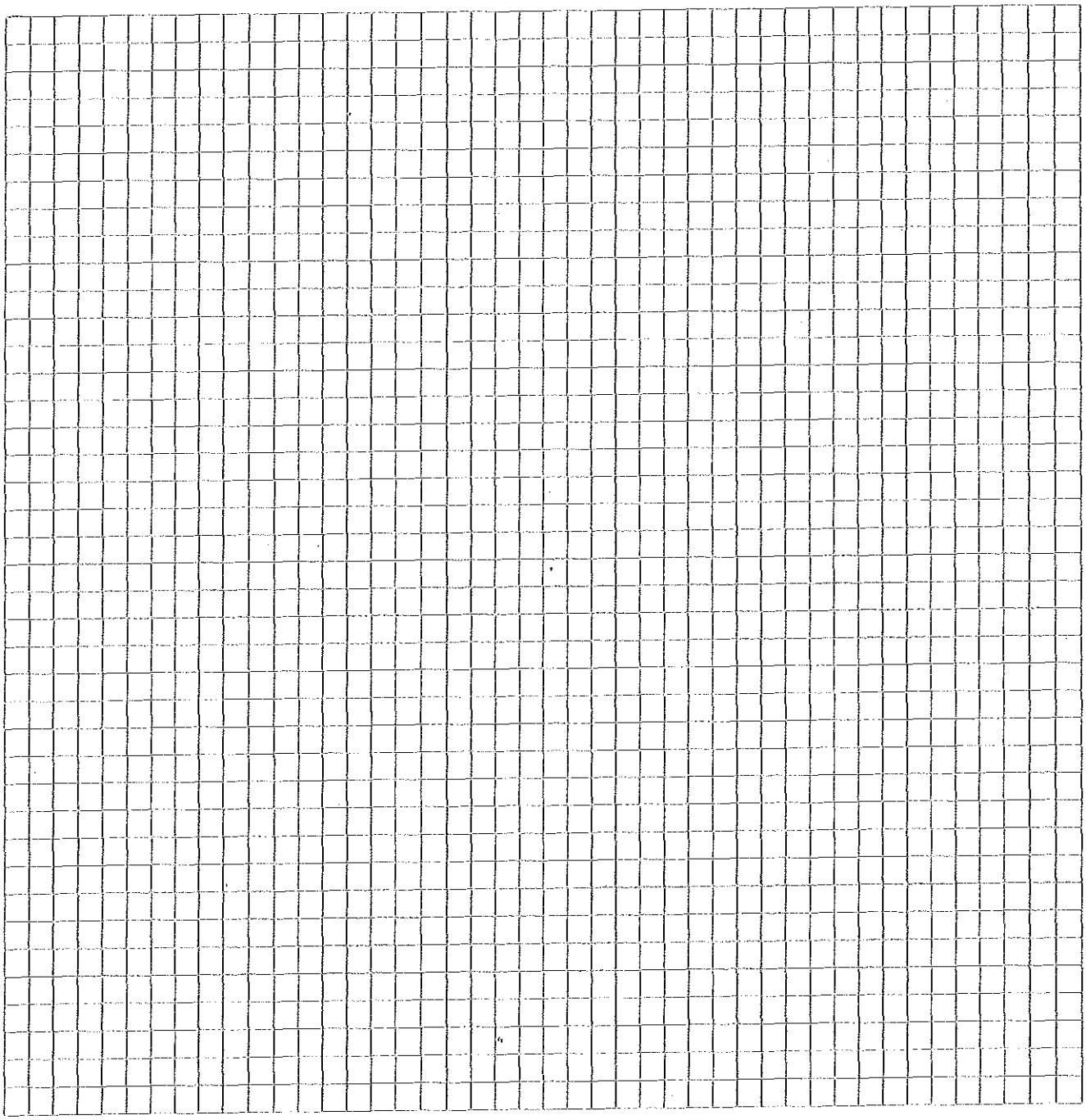
Firs Floor:



Outdoor Plot

Attach or draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.



PART III – HVAC CHARACTERISTICS

Type of heating system (circle all that apply):

Hot air circulation hot air radiation wood steam radiation
Heat pump (hot water radiation) kerosene heater electric baseboard

Other (specify): _____

Type of ventilation system (circle all that apply):

(Central air conditioning) (mechanical fans) (bathroom ventilation fans)
(Individual air conditioning units) (kitchen range hood fan) (outside air intake)

Other (specify): _____

Type of fuel utilized (circle all that apply):

(Natural gas) / electric / fuel oil / wood / coal / solar / kerosene

Is there a whole house fan? Yes / No N/A

Water Supply: (Public) Well Other: _____

Septic system? Yes / Yes (but not used) / (No)

Water Heater Fueled by: Natural gas

Irrigation / private well? Yes / Yes (but not used) / (No)

Type and percent of ground cover outside of building: grass / concrete / asphalt / other (specify) 20% grass 80% concrete

Existing subsurface depressurization (radon) system in place? Yes / (No) active / passive

Sub-slab vapor / moisture barrier in place? Yes / No unknown

Type of barrier: _____

Air Handling Unit

Unit identification 6 Area served: office + labs

Outdoor Air Intake, Mixing Plenum, and Damper

Outdoor air intake location: roof

Nearby contaminant sources? (describe): _____

Bird screen in place and unobstructed? yes

Design total cfm ~170,000 Outdoor air (O.A.) cfm 10-15 Date last tested and balanced: Jan 2012

Minimum % O.A. (damper setting) 10-15 Minimum cft O.A. (total cfm x minimum %O.A.)/100 = _____

Current O.A. damper setting (date, time, and HVAC operating mode): 10-15 %

Damper control sequence (describe): BMS -

Condition of dampers and controls (note date): good

Fans

Control sequence: VFD - BMS Static pressure

Condition (note date): good

Indicated temperatures Supply air: ____ mixed air: ____ return air: 70-73 outdoor air: ____

Actual temperatures Supply air: ____ mixed air: ____ return air: ____ outdoor air: ____

Coils

Heating fluid discharge temperature: ____ ΔT: ____ cooling fluid discharge temperate ____ ΔT: ____

Controls (describe): BMS

Condition (note date): good

Humidifier N/A

Type: ____ if biocide is used, note type: ____

Condition (no overflow, drains trapped, all nozzles working?): ____

No slime, visible growth, or mineral deposits? ____

Boilers

Rated Btu input ____ Condition: ____

Combustion air: is there at least one square inch free area per 2,000 Btu input? ____

Fuel or combustion odors: ____

Cooling Tower

Clean? No leaks or overflow: N/A Slime or algae growth? N/A

Eliminator performance: ____

Biocide treatment working (list type of biocide): 2128 chlorine tabs

Spill containment plan implemented? yes Dirt separator working? yes

Chillers

Refrigerant leaks? N/A

Evidence of condensation problems? N/A

Waste oil and refrigerant properly stored and disposed of? yes

Distribution System

		Supply Air		Return Air		Power Exhaust		
Zone/ Room	System Type	Ducted/ unducted	Cfm*	Ducted/ unducted	cftm*	cfm*	Control	Serves (e.g. toilet)

Condition of distribution system and terminal equipment (note locations of problems)

Adequate access for maintenance? yes

Ducts and coils clean and obstructed? yes

Air paths unobstructed? Supply ____ return: ____ transfer: ____ exhaust: make-up: ____

Note locations of blocked air paths, diffusers, or grilles: N/A

Any unintentional openings into plenums? N/A

Controls operating properly? yes

Air volume correct? yes

Drain pans clean? Any visible growth or odors? PM - Comos

Filters

Location	Type/Rating	Size	Date last Changed	Condition (give date)

Occupied Space

Thermostat Types: TEC - BMS

Zone Room	Thermostat Location	What does Thermostat Control? (e.g. radiator, AHU-3)	Setpoints		Measured Temperature	Day/Time
			Summer	Winter		
			70-73	70-73		

Humidistats/Dehumidistats type: N/A

Zone/Room	Humidistat/ Dehumidistat Location	What Does it Control?	Setpoints (%RH)	Measured Temperature	Day/Time

Potential problems (note location): _____

Thermal comfort or air circulation (drafts, obstructed airflow, stagnant air, overcrowding, poor thermostat location):

_____

_____

Malfunctioning equipment: _____

Major sources of odors of contaminants (e.g., poor sanitation, incompatible uses of space)

_____

Are there air distribution ducts present? Yes/No

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the location on the floor plan diagram.

_____

_____

_____

_____

_____

Part IV – Occupancy

Is basement/lowest level occupied? (Full-time) Occasionally Seldom Almost Never

Level	General Use of Each Floor (e.g. family room, bedroom, laundry, workshop, storage)
Basement	None
1st Floor	OFFICE, R&D labs
2nd floor	OFFICE, R&D Labs
3rd floor	None
4th floor	None

Factors that May Influence Indoor Air Quality

a. Is there an attached garage? Y / (N)

b. Does the garage have a separate heating unit? Y/ N/ (NA)

c. Area petroleum-powered machines or vehicles stored in the garage (e.g. lawnmower, atv, car) Y/ N/ (NA) Please specify _____

d. Has the building ever had a fire? (Y)/ N When? ~2 years ago, mechanical room

e. Is a kerosene or unvented gas space heater present? Y / (N) Where? _____

f. Is there a workshop or hobby/craft area? (Y)/ N Where & Type? R+D Machine Shops

g. Is there smoking in the building? Y / (N) How frequently? _____

h. Have cleaning products been used recently? (Y)/ N When & Type?

i. Have cosmetic products been used recently? (Y) / N When & Type? _____

j. Has painting/staining been done in the last 6 months? (Y) / N Where & When? _____

k. Is there new carpet, drapes or other textiles? (Y) / N Where & When? _____

l. Have air fresheners been used recently? (Y)/ N When & Type? _____

m. Is there a kitchen exhaust fan? (Y)/ N If yes, where vented? _____

n. Is there a bathroom exhaust fant? (Y) / N If yes, where vented? _____

o. Is there a clothes dryer? Y / (N) If yes, is it vented outside? Y/N

p. Has there been a pesticide application? Y / (N) When & Type? _____

Are there odors in the building? Y / (N)

If yes, please describe: _____

Do any of the building occupants use solvents at work? (Y)/ N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)

If yes, what types of solvents are used? IPA, Acetone, solder flux

If yes, are there clothes washed at work? Y / (N)

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly) No
Yes, use dry-cleaning infrequently (monthly or less) (Unknown)
yes, work at a dry-cleaning service

Is there a radon mitigation system for the building/structure? Y /N Date of Installation: _____

Is the system active or passive? Active/Passive

PART V – OUTSIDE CONTAMINANT SOURCES

Known contaminated site (1,000-ft. radius): Building is on OU1 superfund site

Other stationary sources nearby (gas stations, emission stacks, etc.): gas station

Heavy vehicular traffic nearby (or other mobile sources) and distance from building: ~600 ft

PART VI – MISCELLANEOUS ITEMS

Do any occupants of the building smoke? (Yes) / No How often? Unknown
Last time someone smoked in the building? Hours / days ago No smoking inside building

Does the building have an attached garage directly connected to living space? Yes / (No)
If so, is a car usually parked in the garage? Yes / No N/A

Are gas-powered equipment or cans of gasoline/fuels stored in the garage? Yes / No N/A

Do the occupants of the building have their clothes dry cleaned? (Yes) / No
If yes, how often? Weekly / monthly / 304 times a year unknown

Do any of the occupants use solvents in work? (Yes) / No
If yes, what types of solvents are used? IPA, Acetone, flux
If yes, are their clothes washed work? Yes / (No)

Have any pesticides/herbicides been applied around the building or in the yard? Yes / No
If so, when and which chemicals? _____

Has there ever been a fire in the building? (Yes) / No If yes, when? _____

Has painting or staining been done in the building in the last 6 months? (Yes) / No
If yes, when _____ and where? _____

Additional Notes: _____

_____

_____

_____

_____

PART VII – INDOOR CONTAMINANT SOURCES

Identify all potential indoor sources found in the building (including attached garages), the location of the source (floor and room), and whether the item was removed from the building 48 hours prior to indoor air sampling event. Any ventilation implemented after removal of the items should be completed at least 24 hours prior to the commencement of the indoor air sampling event.

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
Gasoline storage cans			
Gas-powered equipment			
Kerosene storage cans			
Paints / thinners / strippers	See attached		
Cleaning solvents			
Oven cleaners			
Carpet / upholstery cleaners			
Other house cleaning products			
Moth balls			
Polishes / waxes			
Insecticides			
Furniture / floor polish			
Nail polish / polish remover			
Hairspray			
Cologne / perfume			
Air fresheners			
Fuel tank (inside building)			
Wood stove or fireplace			
New furniture / upholstery			
New carpeting / flooring			

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
Hobbies – glues, paints, etc.			

Additional Notes: _____

Treadwell&Rollo
A LANGAN COMPANY

Indoor Air Building Survey and Sampling Form

Preparer's name: Elma Fung Date: 11/9/2012

Preparer's affiliation: Environmental Engineer Phone #: (408) 721 3885

Site Name: Texas Instruments Building #: G

PART I – OCCUPANTS

Building Address: 3689 Kifer Road Santa Clara CA 95051

Property Contact: Jim Greene Owner/Renter/Other: Owner

Contact's Phone: home ( ) work: (408) 721 3335 Cell: ( )

# of Building occupants: Children under age 13: 0 Children age 13-18: 0 Adults: 0

PART II – BUILDING CHARACTERISTICS

Building use: residential / multi-family residential / (office) / strip mall / commercial / industrial

Business Type: OFFICE

Describe building: 3 Story building Year constructed: 2001

Sensitive population: day care / nursing home / hospital / school / other (specify): N/A

Multiple Units? Yes / (No) Number of Units:

Number of floors below grade: 0 (full basement / crawl space / slab on grade) Height of each floor (ft.)

Number of floors at or above grade: 3 Height of each floor (ft.) ~9ft to grid

Depth of basement below grade surface: N/A ft. Basement size: 0 ft² Basement Slab thickness: 0 inch

Basement Condition: wet dry damp moldy

Finished unfinished partially finished

Basement floor construction: concrete / dirt / floating / stone / other (specify): N/A

Concrete floor: Unsealed/sealed with: unsealed

Are the basement walls or floor sealed with water proof paint or epoxy coatings? Yes / No N/A

shut down by air cop - no pm

Foundation walls: (Poured concrete) / cinder blocks / stone / other (specify): _____

Basement sump present? Yes / No Sump pump? Yes / No Water in sump? Yes / No

Sump construction: (Poured concrete) / cinder blocks / stone / other (specify)): _____

Elevator Present (Yes / No) # of Elevators: 2

Elevator Shaft details: depth below grade (ft.) ~5ft

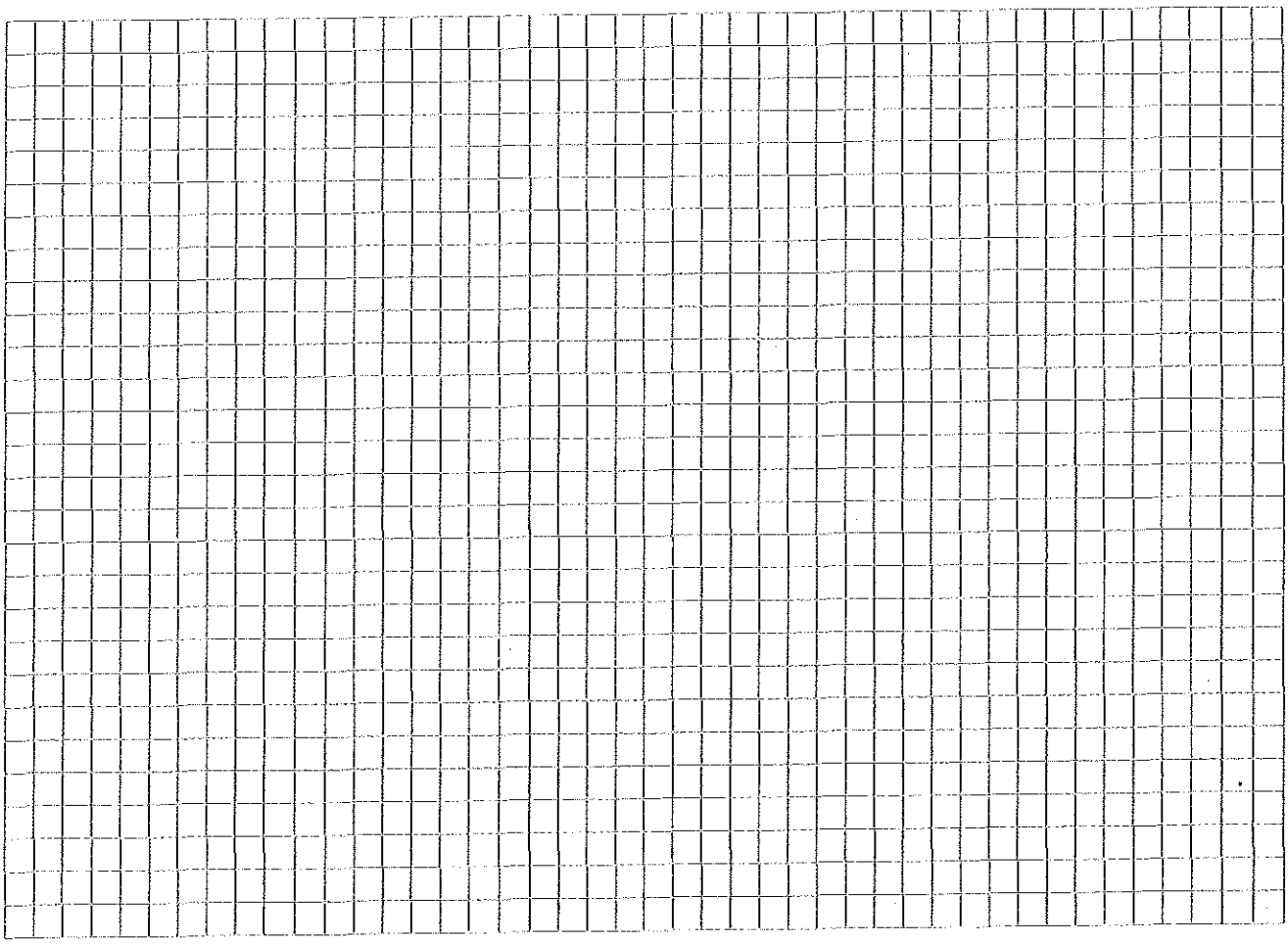
Shaft bottom construction: (Poured concrete) / cinder blocks / stone / other (specify): _____

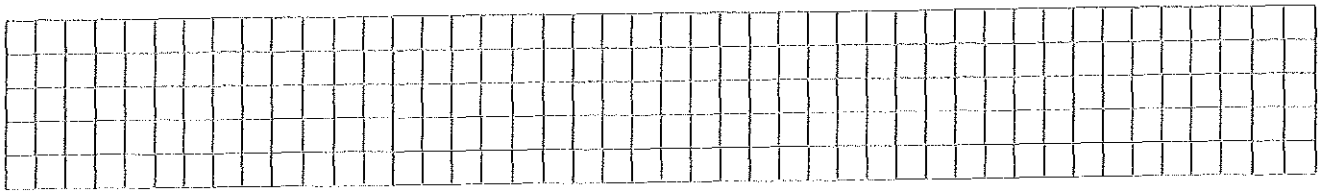
Identify potential vapor entry points and approximate size (cracks, utility point, drains)

FLOOR PLANS

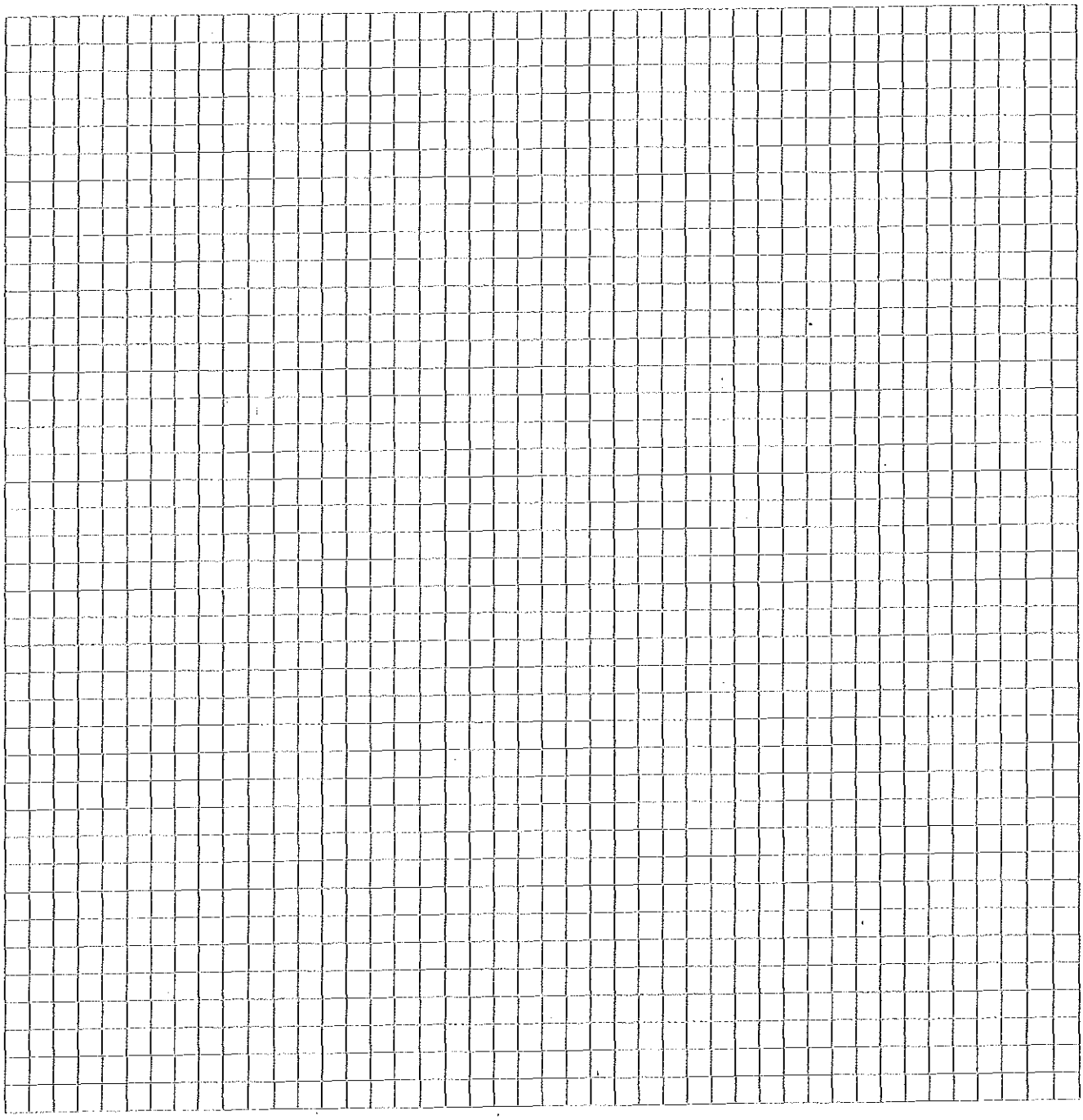
Attach or draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PId meter readings. If the building does not have a basement, please note:

Basement:





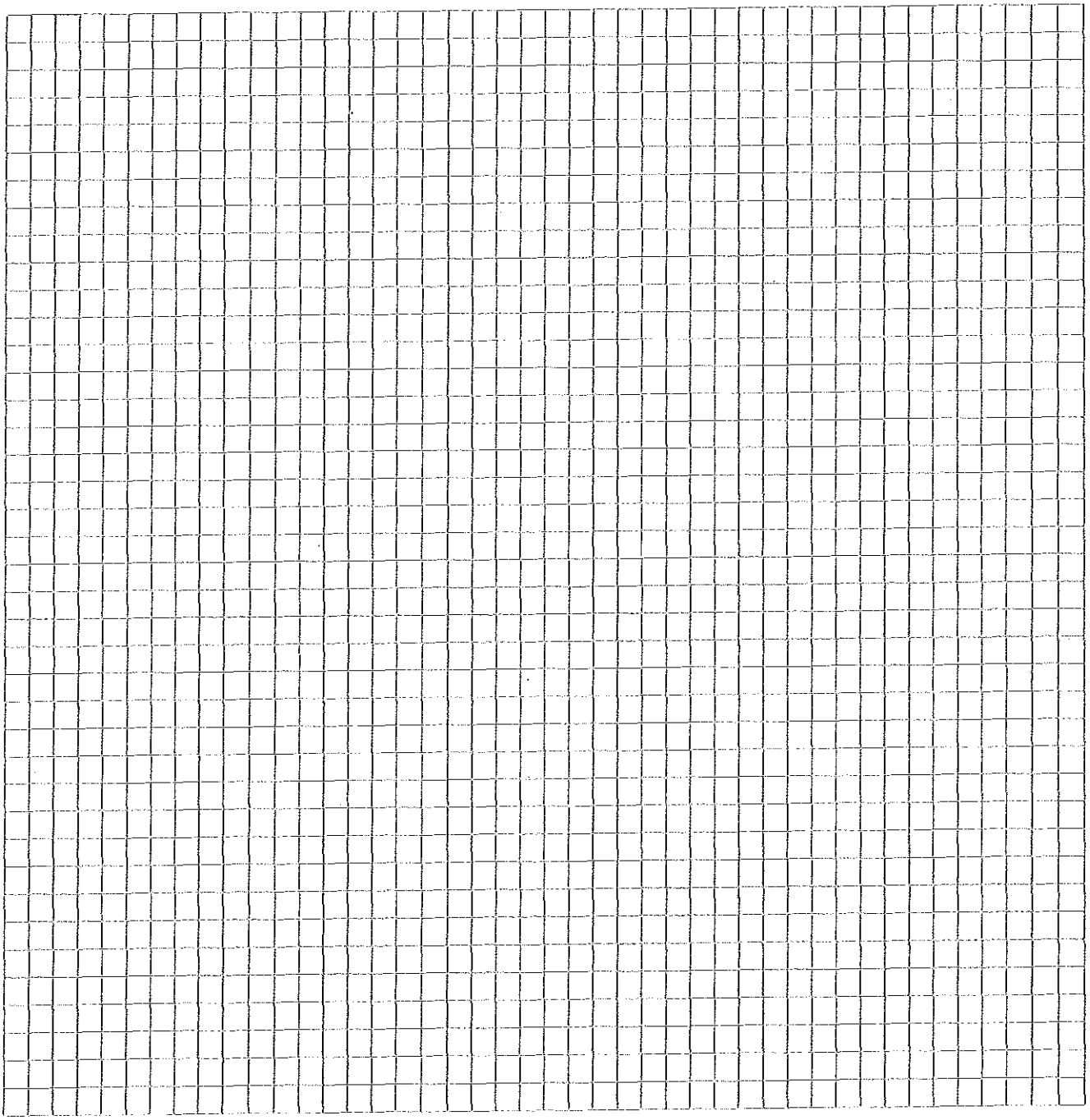
Firs Floor:



Outdoor Plot

Attach or draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.



PART III – HVAC CHARACTERISTICS

Type of heating system (circle all that apply):

Hot air circulation hot air radiation wood steam radiation
Heat pump (hot water radiation) kerosene heater electric baseboard

Other (specify): _____

Type of ventilation system (circle all that apply):

(Central air conditioning) (mechanical fans) (bathroom ventilation fans)
(Individual air conditioning units) (kitchen range hood fan) (outside air intake)

Other (specify): _____

Type of fuel utilized (circle all that apply):

(Natural gas) / electric / fuel oil / wood / coal / solar / kerosene

Is there a whole house fan? Yes / No

Water Supply: (Public) Well Other: _____

Septic system? Yes / Yes (but not used) / (No)

Water Heater Fueled by: _____

Irrigation / private well? Yes / Yes (but not used) / (No)

Type and percent of ground cover outside of building: (grass) / (concrete) / (asphalt) / other (specify) grass - 30% concrete - 70%

Existing subsurface depressurization (radon) system in place? Yes / (No) active / passive

Sub-slab vapor / moisture barrier in place? (Yes) / No

Type of barrier: screen

Air Handling Unit

Unit identification 7 Area served: 1, 2, 3 floors

Outdoor Air Intake, Mixing Plenum, and Damper

Outdoor air intake location: roof (lower + upper)

Nearby contaminant sources? (describe): _____

Bird screen in place and unobstructed? yes

Design total cfm see attached Outdoor air (O.A.) cfm 10 % Date last tested and balanced: ~ 2 years ago

Minimum % O.A. (damper setting) 10-20% Minimum cft O.A. (total cfm x minimum %O.A.)/100 = varies

Current O.A. damper setting (date, time, and HVAC operating mode): Off

Damper control sequence (describe): off

Condition of dampers and controls (note date): fair condition -

Fans

Control sequence: OFF

Condition (note date): _____

Indicated temperatures Supply air: _____ mixed air: _____ return air: _____ outdoor air: _____

Actual temperatures Supply air: _____ mixed air: _____ return air: _____ outdoor air: _____

Coils

Heating fluid discharge temperature: _____ ΔT: _____ cooling fluid discharge temperate _____ ΔT: _____

Controls (describe): _____

Condition (note date): _____

Humidifier

Type: _____ if biocide is used, note type: _____

Condition (no overflow, drains trapped, all nozzles working?): _____

No slime, visible growth, or mineral deposits? _____

Boilers

Rated Btu input ~1 million Condition: good

Combustion air: is there at least one square inch free area per 2,000 Btu input? yes

Fuel or combustion odors: N/A

Cooling Tower

Clean? No leaks or overflow: N/A Slime or algae growth? _____

Eliminator performance: _____

Biocide treatment working (list type of biocide): _____

Spill containment plan implemented? _____ Dirt separator working? _____

Chillers

Refrigerant leaks? N/A

Evidence of condensation problems? _____

Waste oil and refrigerant properly stored and disposed of? _____

Distribution System

		Supply Air		Return Air		Power Exhaust		
Zone/ Room	System Type	Ducted/ unducted	Cfm*	Ducted/ unducted	cftm*	cfm*	Control	Serves (e.g. toilet)

Condition of distribution system and terminal equipment (note locations of problems)

Adequate access for maintenance? yes

Ducts and coils clean and obstructed? yes

Air paths unobstructed? Supply ____ return: ____ transfer: ____ exhaust: make-up: ____

Note locations of blocked air paths, diffusers, or grilles: N/A

Any unintentional openings into plenums? N/A

Controls operating properly? yes

Air volume correct? yes

Drain pans clean? Any visible growth or odors? 6 MOS PM

Filters

Location	Type/Rating	Size	Date last Changed	Condition (give date)

Occupied Space

Thermostat Types: electronic BMS

Zone Room	Thermostat Location	What does Thermostat Control? (e.g. radiator, AHU-3)	Setpoints		Measured Temperature	Day/Time
			Summer	Winter		

Humidistats/Dehumidistats type: _____

Zone/Room	Humidistat/ Dehumidistat Location	What Does it Control?	Setpoints (%RH)	Measured Temperature	Day/Time

Potential problems (note location): _____

Thermal comfort or air circulation (drafts, obstructed airflow, stagnant air, overcrowding, poor thermostat location):

_____

_____

Malfunctioning equipment: _____

Major sources of odors of contaminants (e.g., poor sanitation, incompatible uses of space)

_____

Are there air distribution ducts present? (Yes)/No

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the location on the floor plan diagram.

_____

_____

_____

_____

_____

Part IV – Occupancy

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

Level	General Use of Each Floor (e.g. family room, bedroom, laundry, workshop, storage)
Basement	None
1st Floor	OFFICE
2nd floor	OFFICE
3rd floor	OFFICE
4th floor	None

Factors that May Influence Indoor Air Quality

a.	Is there an attached garage?	Y /(N)	
b.	Does the garage have a separate heating unit?	Y/ N/(NA)	
c.	Area petroleum-powered machines or vehicles stored in the garage (e.g. lawnmower, atv, car)	Y/ N/(NA)	Please specify _____
d.	Has the building ever had a fire?	Y /(N)	When? _____
e.	Is a kerosene or unvented gas space heater present?	Y /(N)	Where? _____
f.	Is there a workshop or hobby/craft area?	Y /(N)	Where & Type? _____
g.	Is there smoking in the building?	Y /(N)	How frequently? _____
h.	Have cleaning products been used recently?	Y /(N)	When & Type?
i.	Have cosmetic products been used recently?	Y /(N)	When & Type? _____
j.	Has painting/staining been done in the last 6 months?	Y /(N)	Where & When? _____
k.	Is there new carpet, drapes or other textiles?	Y /(N)	Where & When? _____
l.	Have air fresheners been used recently?	Y /(N)	When & Type? _____
m.	Is there a kitchen exhaust fan?	(Y)/ N	If yes, where vented? _____
n.	Is there a bathroom exhaust fant?	(Y)/ N	If yes, where vented? _____
o.	Is there a clothes dryer?	Y /(N)	If yes, is it vented outside? Y/N
p.	Has there been a pesticide application?	Y /(N)	When & Type? _____

Are there odors in the building? Y /(N)

If yes, please describe: _____

Do any of the building occupants use solvents at work? Y /(N)
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)

If yes, what types of solvents are used? _____

If yes, are there clothes washed at work? Y /(N)

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly) (No)
Yes, use dry-cleaning infrequently (monthly or less) (Unknown)
yes, work at a dry-cleaning service

Is there a radon mitigation system for the building/structure? Y /(N) Date of Installation: _____

Is the system active or passive? Active/Passive

PART V – OUTSIDE CONTAMINANT SOURCES

Known contaminated site (1,000-ft. radius): Superfund site

Other stationary sources nearby (gas stations, emission stacks, etc.): gas station, air stripper

Heavy vehicular traffic nearby (or other mobile sources) and distance from building: ~300ft

PART VI – MISCELLANEOUS ITEMS

Do any occupants of the building smoke? Yes / (No) How often? Bldg empty
Last time someone smoked in the building? Hours / days ago N/A

Does the building have an attached garage directly connected to living space? Yes /(No)
If so, is a car usually parked in the garage? Yes / No N/A

Are gas-powered equipment or cans of gasoline/fuels stored in the garage? Yes / No N/A

Do the occupants of the building have their clothes dry cleaned? Yes / No N/A
If yes, how often? Weekly / monthly / 304 times a year

Do any of the occupants use solvents in work? Yes /(No)
If yes, what types of solvents are used? _____
If yes, are their clothes washed work? Yes / No N/A

Have any pesticides/herbicides been applied around the building or in the yard? Yes /(No)
If so, when and which chemicals? _____

Has there ever been a fire in the building? Yes / (No) If yes, when? _____

Has painting or staining been done in the building in the last 6 months? Yes /(No)
If yes, when _____ and where? _____

Additional Notes: _____

_____

_____

_____

_____

PART VII – INDOOR CONTAMINANT SOURCES See attached

Identify all potential indoor sources found in the building (including attached garages), the location of the source (floor and room), and whether the item was removed from the building 48 hours prior to indoor air sampling event. Any ventilation implemented after removal of the items should be completed at least 24 hours prior to the commencement of the indoor air sampling event.

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
Gasoline storage cans			
Gas-powered equipment			
Kerosene storage cans			
Paints / thinners / strippers			
Cleaning solvents			
Oven cleaners			
Carpet / upholstery cleaners			
Other house cleaning products			
Moth balls			
Polishes / waxes			
Insecticides			
Furniture / floor polish			
Nail polish / polish remover			
Hairspray			
Cologne / perfume			
Air fresheners			
Fuel tank (inside building)			
Wood stove or fireplace			
New furniture / upholstery			
New carpeting / flooring			

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
Hobbies – glues, paints, etc.			

Additional Notes: _____

Indoor Air Building Survey and Sampling Form

Preparer's name: Elma Fung Date: 2/19/2014

Preparer's affiliation: EGH manager Santa Clara Phone #: (669) 721-3865

Site Name: Texas Instruments, Inc. Building #: M

PART I – OCCUPANTS

Building Address: 2900 Semiconductor Dr, Santa Clara CA 95051

Property Contact: Jim Greene Owner/Renter/Other: _____

Contact's Phone: home ( ) _____ work: (669) 721 3335 Cell: (920) 940 - 4135

# of Building occupants: Children under age 13: 0 Children age 13-18: 0 Adults: 30

PART II – BUILDING CHARACTERISTICS

Building use: residential / multi-family residential / (office) / strip mall / commercial / industrial

Business Type: OFFICE and Labs

Describe building: Two story Year constructed: 1984

_____

Sensitive population: day care / nursing home / hospital / school / other (specify): N/A

Multiple Units? Yes/(No) Number of Units: _____

Number of floors below grade: 0 (full basement / crawl space / slab on grade) Height of each floor (ft.) _

Number of floors at or above grade: 2 Height of each floor (ft.) 9-10 ft to ceiling grade

Depth of basement below grade surface: ____ ft. Basement size: _____ ft² Basement Slab thickness: ___inch

Basement Condition: wet dry damp moldy

Finished unfinished partially finished

Basement floor construction: concrete / dirt / floating / stone / other (specify): N/A

Concrete floor: Unsealed/sealed with: sealed w/ epoxy coating

Are the basement walls or floor sealed with water proof paint or epoxy coatings? Yes / No N/A

Foundation walls: (Poured concrete) / cinder blocks / stone / other (specify): _____

Basement sump present? Yes /(No) Sump pump? Yes / NoWater in sump?Yes / No N/A

Sump construction: Poured concrete / cinder blocks / stone / other (specify)): _____

Elevator Present (Yes /(No) # of Elevators: _____

Elevator Shaft details: depth below grade (ft.) _____

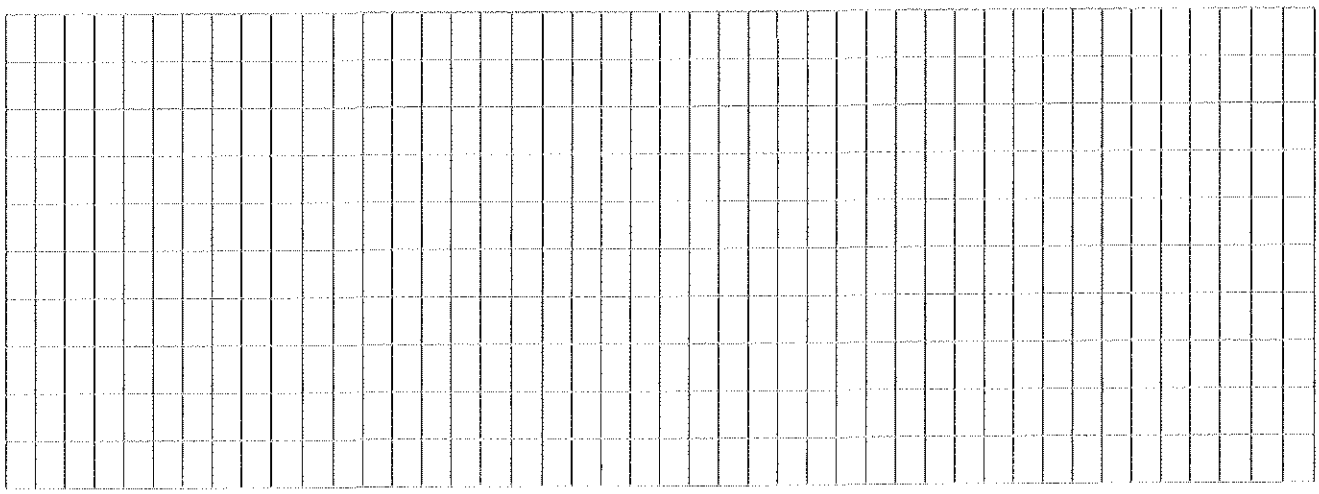
Shaft bottom construction: Poured concrete / cinder blocks / stone / other (specify): _____

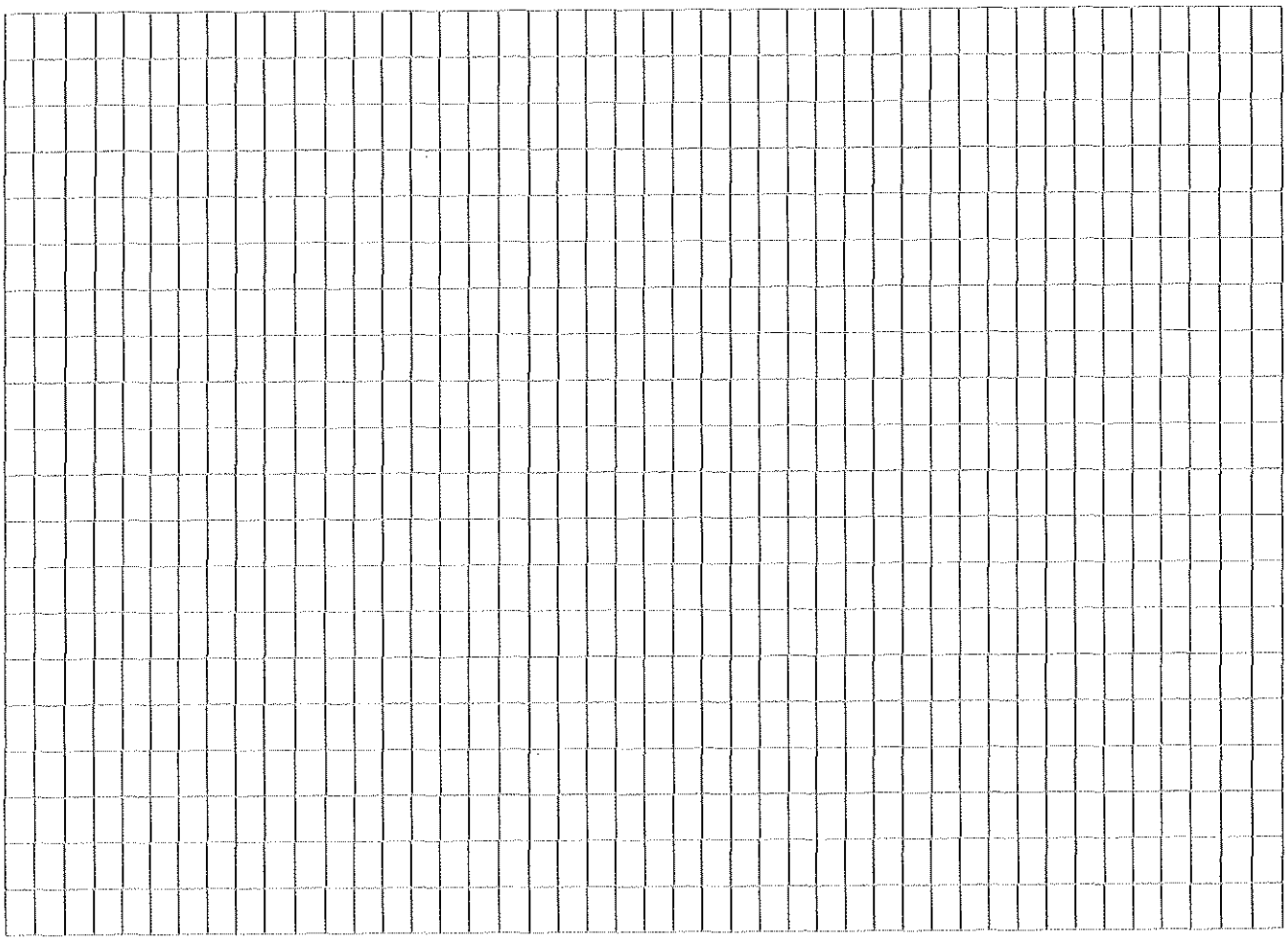
Identify potential vapor entry points and approximate size (cracks, utility point, drains)

FLOOR PLANS

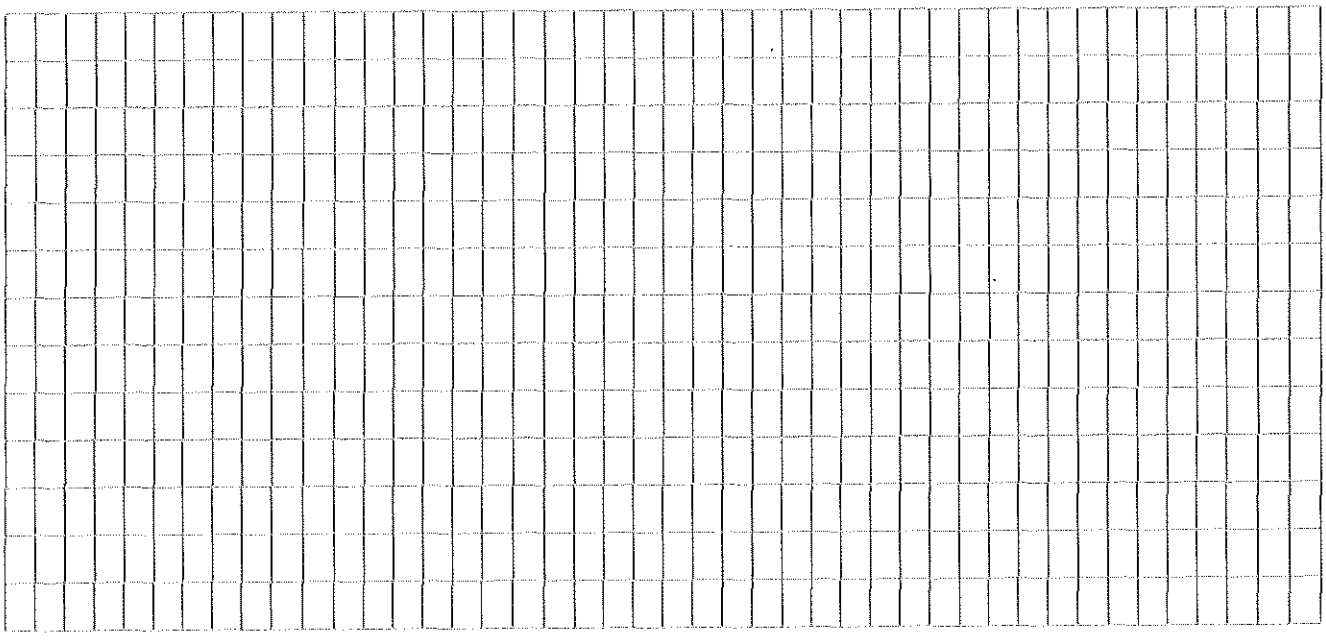
Attach or draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PId meter readings. If the building does not have a basement, please note:

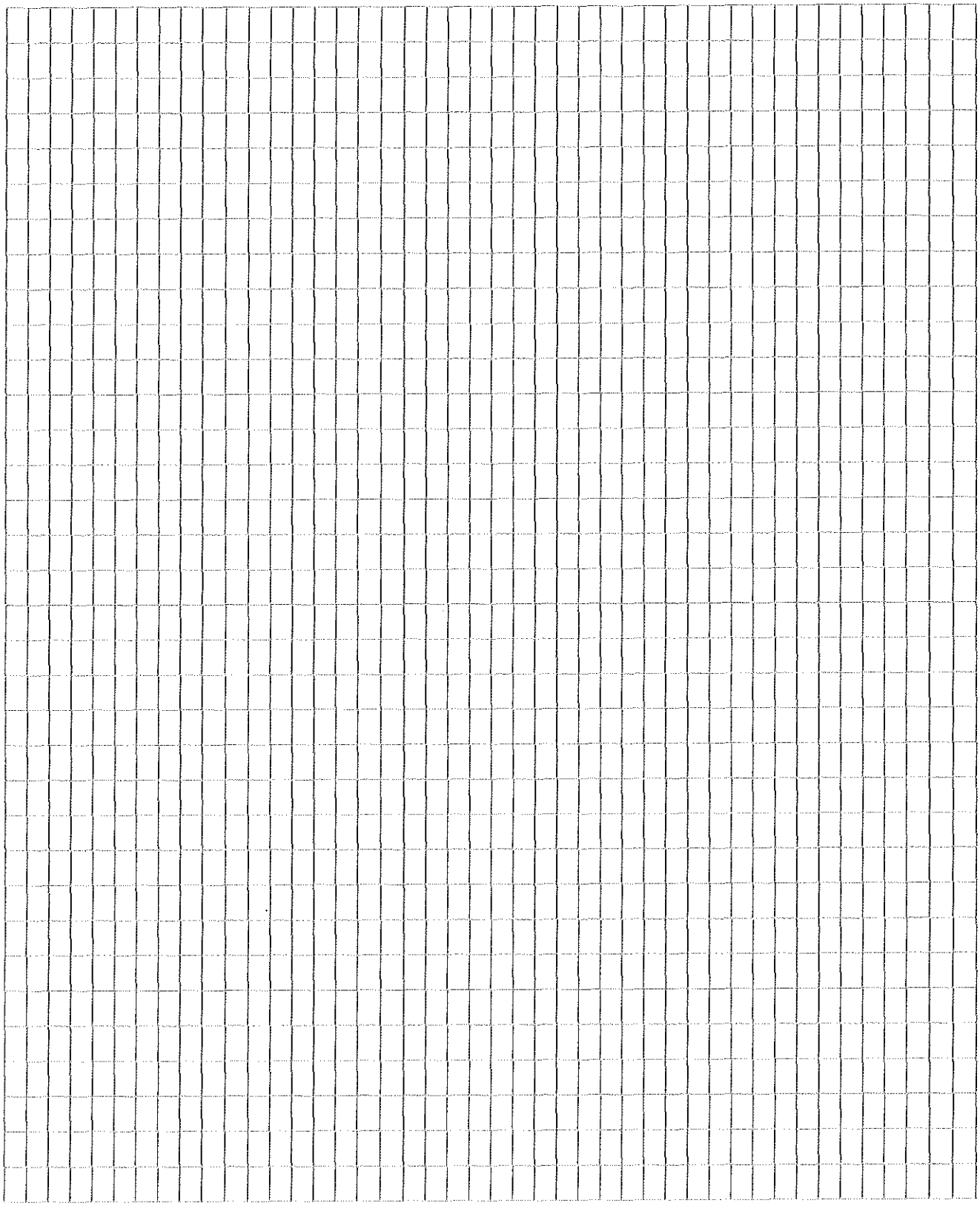
Basement:





Firs Floor:

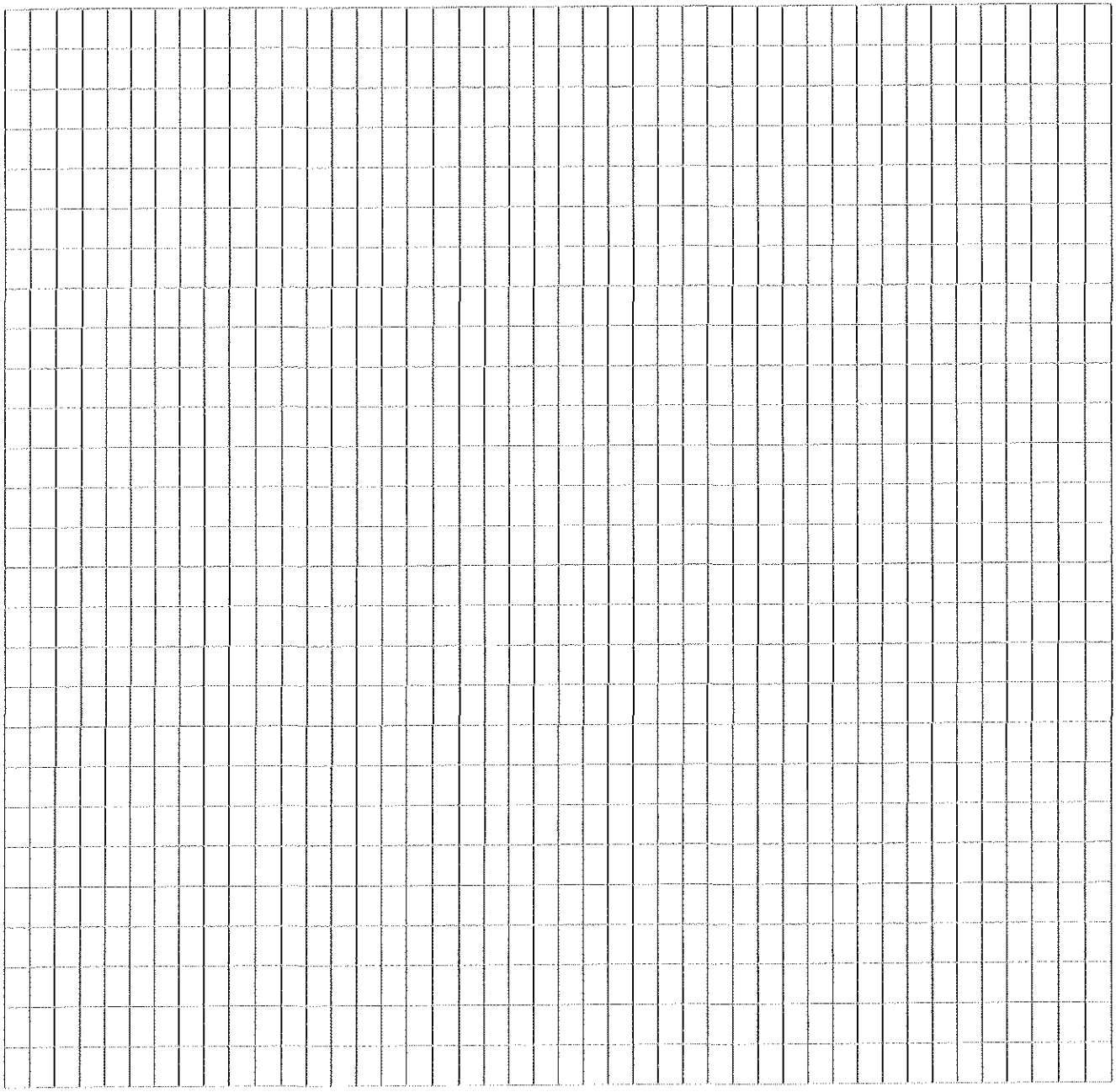


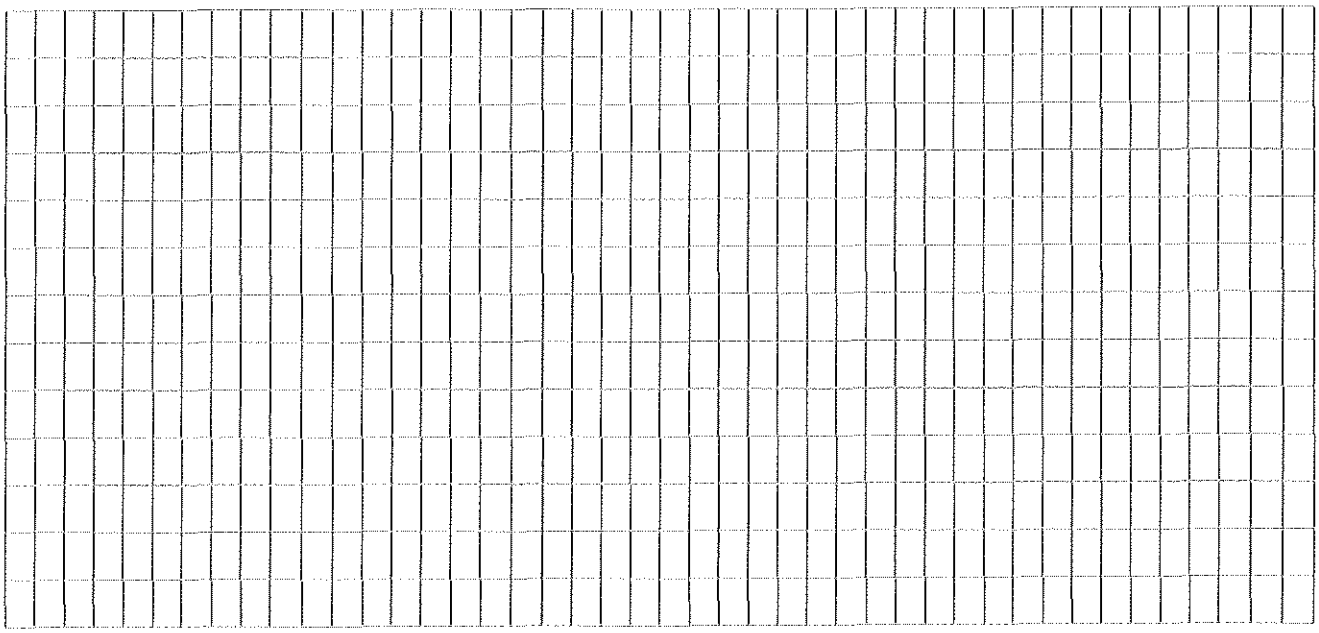


Outdoor Plot

Attach or draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.





PART III – HVAC CHARACTERISTICS

Type of heating system (circle all that apply):

Hot air circulation hot air radiation wood steam radiation

Heat pump (hot water radiation) kerosene heater electric baseboard

Other (specify): _____

Type of ventilation system (circle all that apply): ask what central

(Central air conditioning) mechanical fans bathroom ventilation fans

(Individual air conditioning units) kitchen range hood fan (outside air intake)

Other (specify): _____

Type of fuel utilized (circle all that apply):

(Natural gas) / electric / fuel oil / wood / coal / solar / kerosene

Is there a whole house fan? Yes / (No)

Water Supply: Public Well Other: none - no bathroom or breakroom

Septic system? Yes / Yes (but not used) / (No)

Water Heater Fueled by: none

Irrigation / private well? Yes / Yes (but not used) / (No)

Type and percent of ground cover outside of building: grass / concrete / asphalt / other (specify) 100% Concrete

Existing subsurface depressurization (radon) system in place? Yes / (No) active / passive

Sub-slab vapor / moisture barrier in place? Yes / (No)

Type of barrier: _____

Air Handling Unit

Unit identification 5 [HVAC 1,2,3,4,5] Area served: OFFICE & LAB

Outdoor Air Intake, Mixing Plenum, and Damper

Outdoor air intake location: roof

Nearby contaminant sources? (describe): _____

Bird screen in place and unobstructed? yes

Design total cfm _____ Outdoor air (O.A.) cfm 10% Date last tested and balanced: PM every 6 mos.

Minimum % O.A. (damper setting) 10% Minimum cft O.A. (total cfm x minimum %O.A.)/100 = _____

Current O.A. damper setting (date, time, and HVAC operating mode): 10% HVAC 1,2 24 hours ~~HVAC 3,4,5 6am - 6pm~~

Damper control sequence (describe): dependent on outside temp [HVAC 1,2]

Condition of dampers and controls (note date): good

Fans

Control sequence: 100% all the time

Condition (note date): good

Indicated temperatures Supply air: ~55F mixed air: ~70F return air: ~72F outdoor air: _____

Actual temperatures Supply air: ~55F mixed air: ~70F return air: ~72F outdoor air: _____

Coils

Heating fluid discharge temperature: 160F ΔT: 20F cooling fluid discharge temperate 55F ΔT: 0F

Controls (describe): T9-300 thermostat

Condition (note date): good

Humidifier

Type: none if biocide is used, note type: _____

Condition (no overflow, drains trapped, all nozzles working?): _____

No slime, visible growth, or mineral deposits? _____

Boilers

Rated Btu input none Condition: good

Combustion air: is there at least one square inch free area per 2,000 Btu input? _____

Fuel or combustion odors: _____

Cooling Tower

Clean? No leaks or overflow: none Slime or algae growth? _____

Eliminator performance: _____

Biocide treatment working (list type of biocide): _____

Spill containment plan implemented? _____ Dirt separator working? _____

Chillers

Refrigerant leaks? none

Evidence of condensation problems? _____

Waste oil and refrigerant properly stored and disposed of? _____

Distribution System

		Supply Air		Return Air		Power Exhaust		
Zone/ Room	System Type	Ducted/ unducted	Cfm*	Ducted/ unducted	cftm*	cfm*	Control	Serves (e.g. toilet)

Condition of distribution system and terminal equipment (note locations of problems)

Adequate access for maintenance? yes

Ducts and coils clean and obstructed? yes

Air paths unobstructed? Supply ✓ return: ✓ transfer: ✓ exhaust: make-up: ✓

Note locations of blocked air paths, diffusers, or grilles: none

Any unintentional openings into plenums? none

Controls operating properly? yes

Air volume correct? yes

Drain pans clean? Any visible growth or odors? none

Filters

Location	Type/Rating	Size	Date last Changed	Condition (give date)
on each HVAC	Aerostar Pleat	varies 20x25x2	at least every year	good
unit		20x20x2		
		16x20x2		

Occupied Space

Thermostat Types: T7300 Honeywell

Zone Room	Thermostat Location	What does Thermostat Control? (e.g. radiator, AHU-3)	Setpoints		Measured Temperature	Day/Time
			Summer	Winter		
			room Temp	room Temp		
2	OFFICE	HVAC 4,5	70-74	70-74		6am-6pm
1	LAB 2nd floor	HVAC 3	70-74	70-74		6am-6pm
2	LABS 1st floor	HVAC 1,2	70-74	70-74		24 hours

Humidistats/Dehumidistats type: none

Zone/Room	Humidistat/ Dehumidistat Location	What Does it Control?	Setpoints (%RH)	Measured Temperature	Day/Time

Potential problems (note location): _____

Thermal comfort or air circulation (drafts, obstructed airflow, stagnant air, overcrowding, poor thermostat location):

_____

_____

Malfunctioning equipment: _____

Major sources of odors of contaminants (e.g., poor sanitation, incompatible uses of space)

_____

Are there air distribution ducts present? Yes (No)

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the location on the floor plan diagram.

duct is above grid. Good condition

_____

_____

_____

_____

Part IV – Occupancy

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

Level	General Use of Each Floor (e.g. family room, bedroom, laundry, workshop, storage)
Basement	none
1st Floor	Occassionally
2nd floor	Full-time fully occupied
3rd floor	
4th floor	

Factors that May Influence Indoor Air Quality

a. Is there an attached garage? Y / (N)

b. Does the garage have a separate heating unit? Y/ N/ (NA)

c. Area petroleum-powered machines or vehicles stored in the garage (e.g. lawnmower, atv, car) Y/ N/ (NA) Please specify _____

d. Has the building ever had a fire? Y / (N) When? _____

e. Is a kerosene or unvented gas space heater present? Y / (N) Where? _____

f. Is there a workshop or hobby/craft area? Y / (N) Where & Type? _____

g. Is there smoking in the building? Y / (N) How frequently? _____

h. Have cleaning products been used recently? (Y)/ N When & Type?

i. Have cosmetic products been used recently? Y / (N) When & Type? _____

j. Has painting/staining been done in the last 6 months? Y / (N) Where & When? _____

k. Is there new carpet, drapes or other textiles? Y / (N) Where & When? _____

l. Have air fresheners been used recently? Y / (N) When & Type? _____

m. Is there a kitchen exhaust fan? Y / (N) If yes, where vented? No bredcrooms

n. Is there a bathroom exhaust fant? Y / (N) If yes, where vented? No Bathrooms

o. Is there a clothes dryer? Y / (N) If yes, is it vented outside? Y/N

p. Has there been a pesticide application? Y / (N) When & Type? _____

Are there odors in the building? Y / (N)

If yes, please describe: _____

Do any of the building occupants use solvents at work? (Y)/ N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)

If yes, what types of solvents are used? IPA, Acetone

If yes, are there clothes washed at work? Y /(N)

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly) No
Yes, use dry-cleaning infrequently (monthly or less) (Unknown)
yes, work at a dry-cleaning service

Is there a radon mitigation system for the building/structure? Y (N) Date of Installation: _____

Is the system active or passive? Active/Passive N/A

PART V – OUTSIDE CONTAMINANT SOURCES

Known contaminated site (1,000-ft. radius): _____

Other stationary sources nearby (gas stations, emission stacks, etc.): _____

Heavy vehicular traffic nearby (or other mobile sources) and distance from building: _____

PART VI – MISCELLANEOUS ITEMS

Do any occupants of the building smoke? (Yes) / No How often? unknown

Last time someone smoked in the building? N/A Hours / c

Does the building have an attached garage directly connected to living space? Yes / (No)

If so, is a car usually parked in the garage? Yes / (No)

Are gas-powered equipment or cans of gasoline/fuels stored in the garage? Yes / (No)

Do the occupants of the building have their clothes dry cleaned? (Yes) / No

If yes, how often? Weekly / monthly / 304 times a year unknown

Do any of the occupants use solvents in work? (Yes) / No

If yes, what types of solvents are used? IPA, Acetone

If yes, are their clothes washed work? Yes / (No)

Have any pesticides/herbicides been applied around the building or in the yard? Yes / (No)

If so, when and which chemicals? _____

Has there ever been a fire in the building? Yes / (No) If yes, when? _____

Has painting or staining been done in the building in the last 6 months? Yes / (No)

If yes, when _____ and where? _____

Additional Notes: _____

_____

_____

_____

_____

PART VII – INDOOR CONTAMINANT SOURCES

Identify all potential indoor sources found in the building (including attached garages), the location of the source (floor and room), and whether the item was removed from the building 48 hours prior to indoor air sampling event. Any ventilation implemented after removal of the items should be completed at least 24 hours prior to the commencement of the indoor air sampling event.

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
Gasoline storage cans			
Gas-powered equipment			
Kerosene storage cans			
Paints / thinners / strippers			
Cleaning solvents	✓		
Oven cleaners			
Carpet / upholstery	✓		

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
cleaners	✓		
Other house cleaning products	✓		
Moth balls			
Polishes / waxes	✓		
Insecticides	✓		
Furniture / floor polish			
Nail polish / polish remover	✓		
Hairspray	✓		
Cologne / perfume	✓		
Air fresheners			
Fuel tank (inside building)			
Wood stove or fireplace			
New furniture / upholstery			
New carpeting / flooring			
Hobbies – glues, paints, etc.			

Additional Notes: _____

_____

Indoor Air Building Survey and Sampling Form

Preparer's name: Ema Fung Date: 2/19/14

Preparer's affiliation: EsH manager Santa Clara Phone #: (669) 721 3885

Site Name: Texas Instruments, Inc. Building #: W

PART I – OCCUPANTS

Building Address: 3885 Kifer Rd Santa Clara CA 95051

Property Contact: Jim Greene (Owner)/Renter/Other: _____

Contact's Phone: home ( ) _____ work: (669) 721 3335 Cell: (520) 940-4135

# of Building occupants: Children under age 13: 0 Children age 13-18: 0 Adults: 20

PART II – BUILDING CHARACTERISTICS

Building use: residential / multi-family residential / (office) / strip mall / commercial / industrial

Business Type: OFFICE, LABS And warehouse

Describe building: Two story Year constructed: 1958

Sensitive population: day care / nursing home / hospital / school / other (specify): _____

Multiple Units? Yes/(No) Number of Units: _____

Number of floors below grade: 0 (full basement / crawl space / slab on grade) Height of each floor (ft.) _

Number of floors at or above grade: 2 Height of each floor (ft.) 9-10ft to ceiling grid warehouse 20 ft

Depth of basement below grade surface: ____ ft. Basement size: _____ ft² Basement Slab thickness: ___inch

Basement Condition: wet dry damp moldy

Finished unfinished partially finished

Basement floor construction: concrete / dirt / floating / stone / other (specify): N/A

Concrete floor: (Unsealed)/sealed with: _____

Are the basement walls or floor sealed with water proof paint or epoxy coatings? Yes / No N/A

Foundation walls: (Poured concrete) / cinder blocks / stone / other (specify): _____

Basement sump present? Yes / No Sump pump? Yes / NoWater in sump?Yes / No N/A

Sump construction: Poured concrete / cinder blocks / stone / other (specify)): _____

Elevator Present (Yes / No) # of Elevators: 1

Elevator Shaft details: depth below grade (ft.) NO Shaft below grade

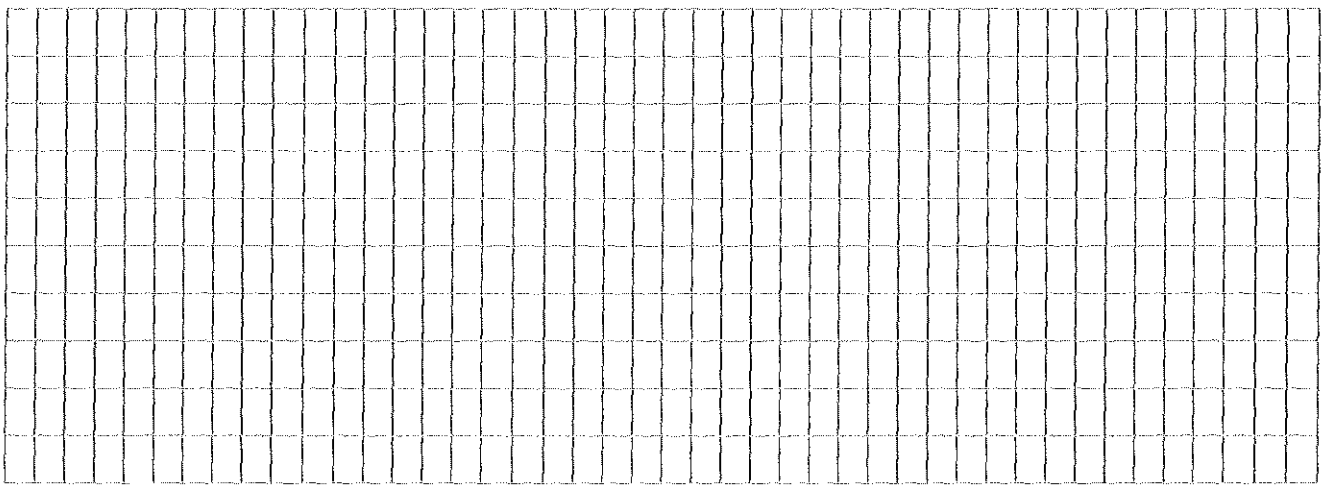
Shaft bottom construction: Poured concrete / cinder blocks / stone / other (specify): _____

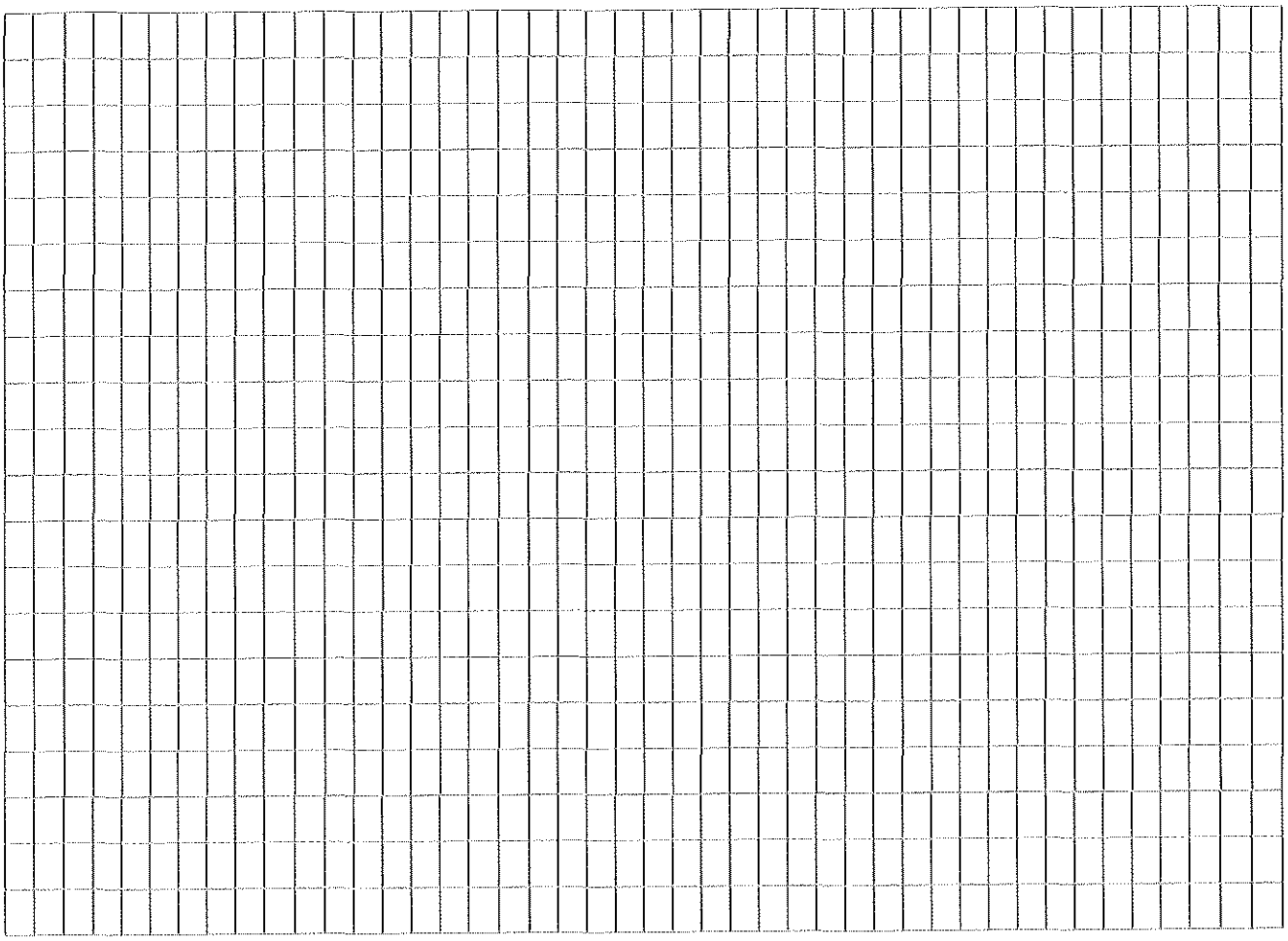
Identify potential vapor entry points and approximate size (cracks, utility point, drains)

FLOOR PLANS

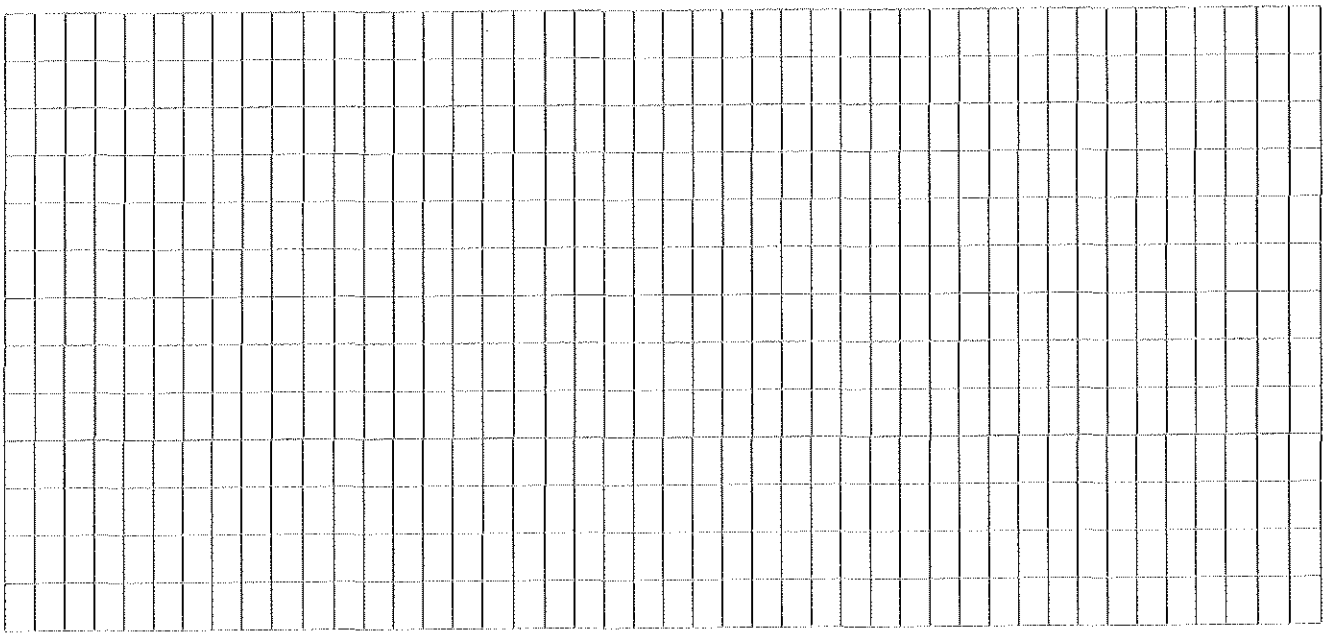
Attach or draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PId meter readings. If the building does not have a basement, please note:

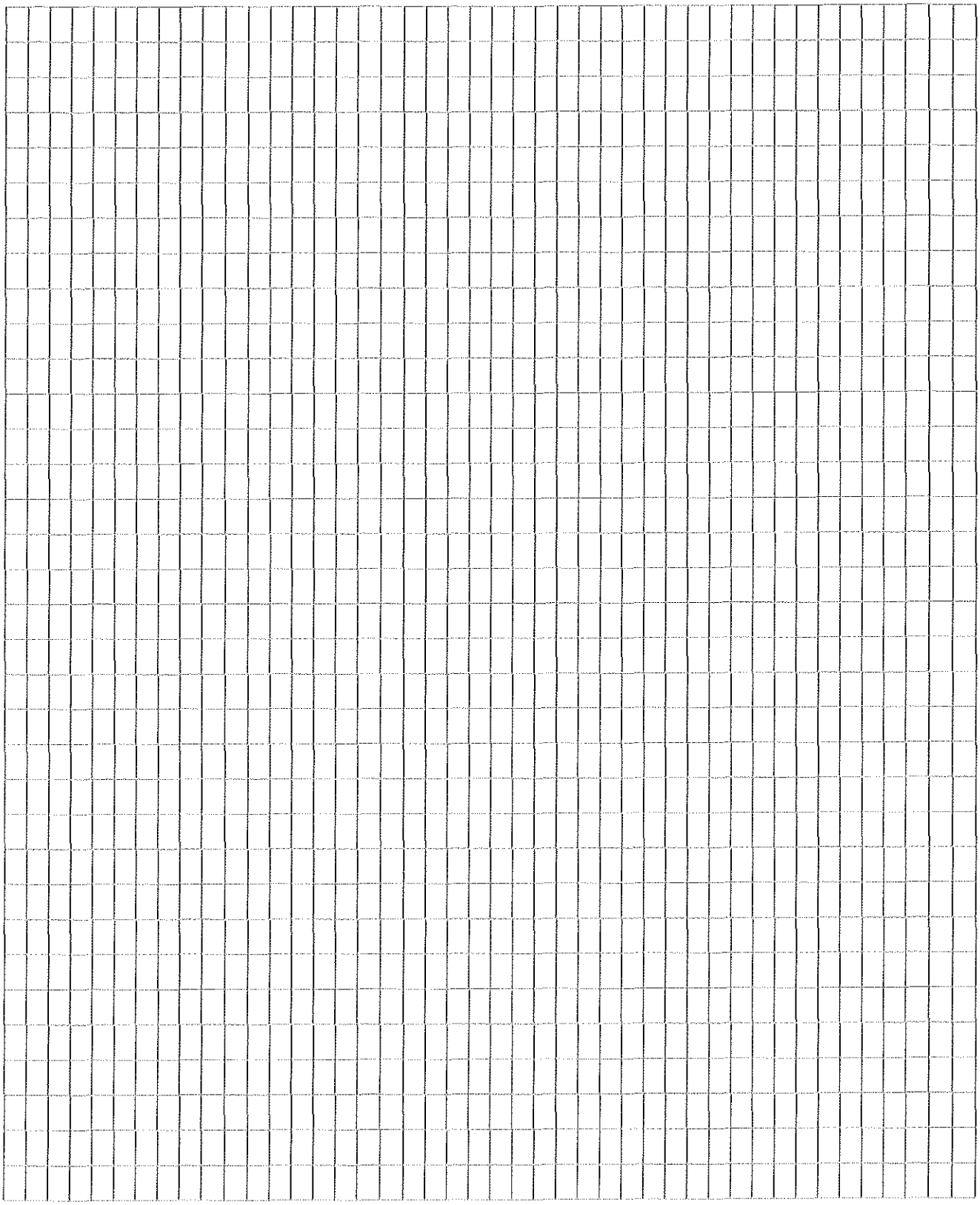
Basement:





Firs Floor:

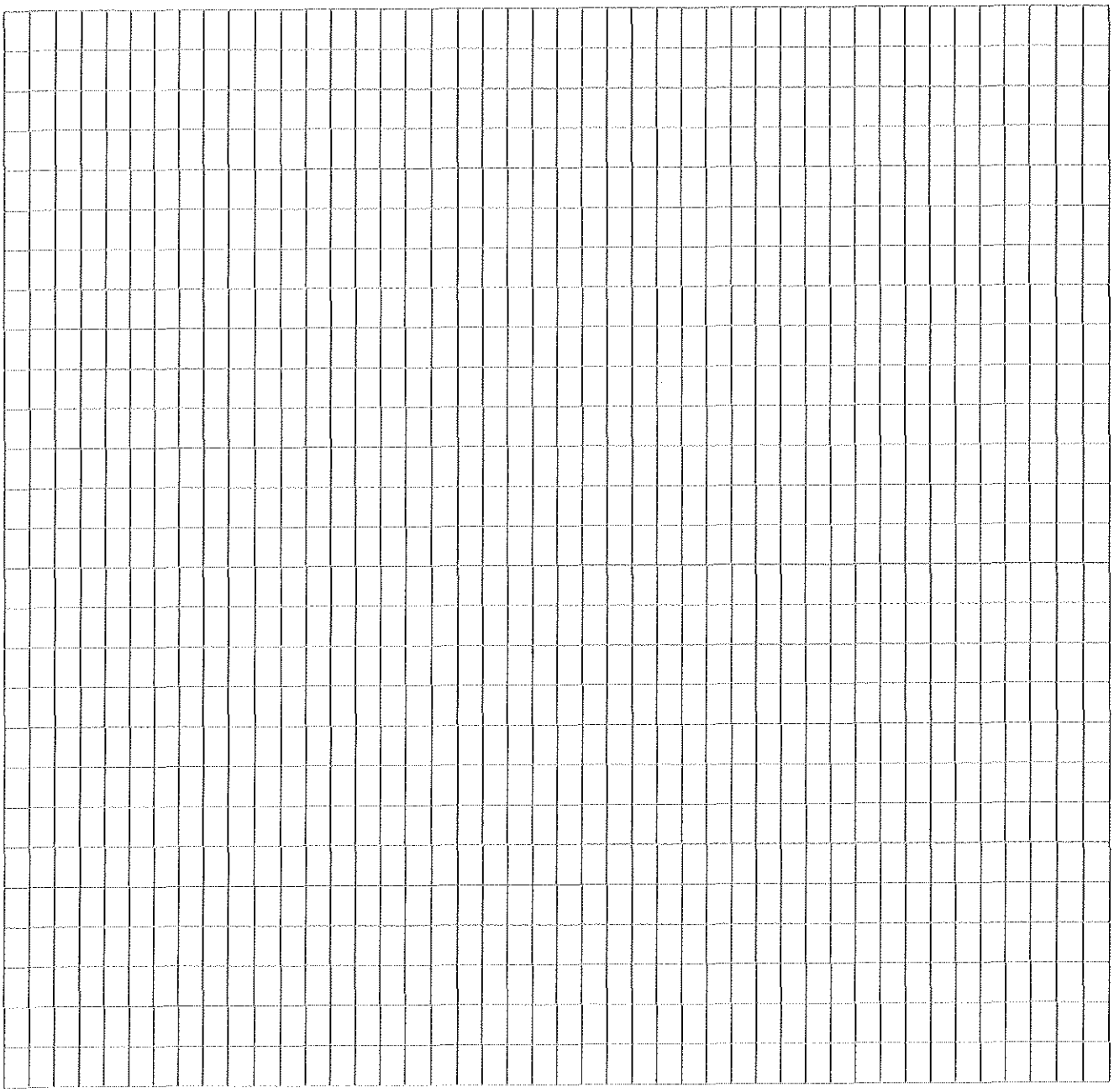


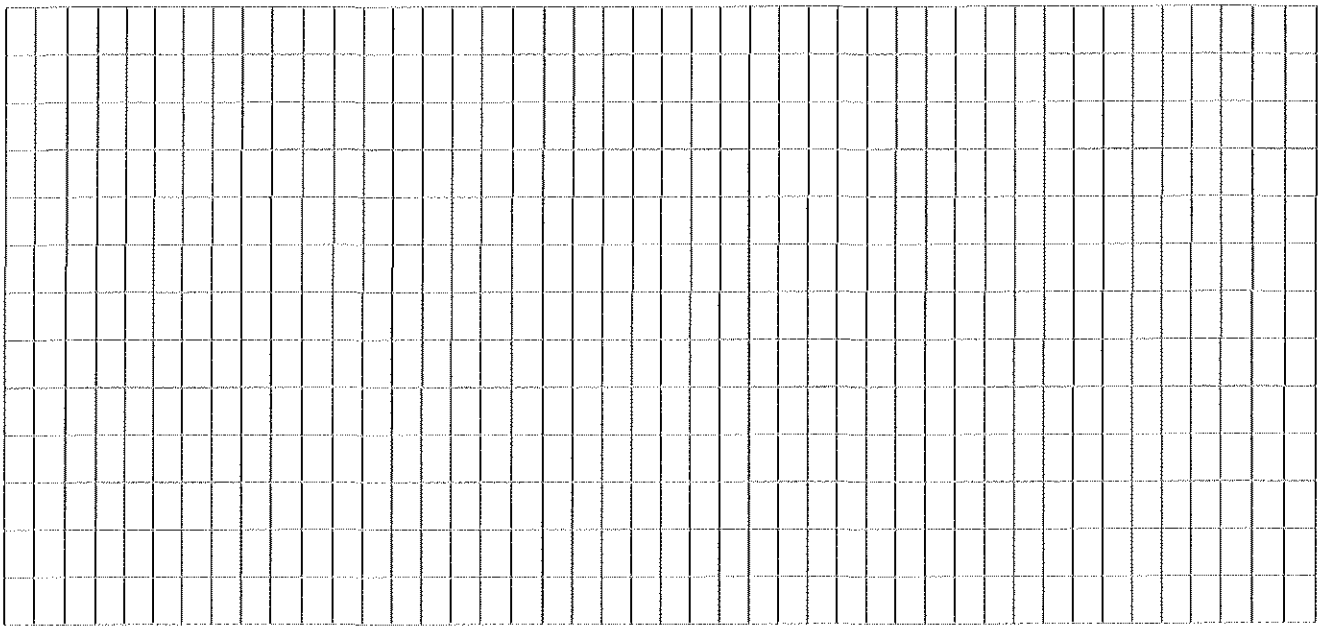


Outdoor Plot

Attach or draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.





PART III – HVAC CHARACTERISTICS

Type of heating system (circle all that apply):

Hot air circulation hot air radiation wood steam radiation

Heat pump (hot water radiation) kerosene heater electric baseboard

Other (specify): _____

Type of ventilation system (circle all that apply):

(Central air conditioning) (mechanical fans) (bathroom ventilation fans)

(Individual air conditioning units) kitchen range hood fan (outside air intake)

Other (specify): _____

Type of fuel utilized (circle all that apply):

(Natural gas) electric / fuel oil / wood / coal / solar / kerosene

Is there a whole house fan? (Yes) / No there ceiling fans in the warehouse

Water Supply: Public Well Other: _____

Septic system? Yes / Yes (but not used) / (No)

Water Heater Fueled by: electrical

Irrigation / private well? Yes / Yes (but not used) (No)

Type and percent of ground cover outside of building: grass / concrete / asphalt / other (specify) 95% concrete 5% grass

Existing subsurface depressurization (radon) system in place? Yes / (No) active / passive

Sub-slab vapor / moisture barrier in place? Yes / (No)

Type of barrier: _____

Air Handling Unit

Unit identification HVAC 6,7,9,12 Area served: Labs, office area

Outdoor Air Intake, Mixing Plenum, and Damper

Outdoor air intake location: HVAC 1,2,6,7 on roof HVAC 9 ground

Nearby contaminant sources? (describe): parking lot by HVAC 9

Bird screen in place and unobstructed? yes

Design total cfm _____ Outdoor air (O.A.) cfm ~10% Date last tested and balanced: PM every 6 mos.

Minimum % O.A. (damper setting) 10% Minimum cft O.A. (total cfm x minimum %O.A.)/100 = _____

Current O.A. damper setting (date, time, and HVAC operating mode): minimum 10%

Damper control sequence (describe): controlled by room temp & outside air

Condition of dampers and controls (note date): good

Fans

Control sequence: constant

Condition (note date): good

Indicated temperatures Supply air: ~55F mixed air: ~65F return air: ~72F outdoor air: _____

Actual temperatures Supply air: ~55F mixed air: ~65F return air: ~72F outdoor air: _____

Coils

Heating fluid discharge temperature: ~100F ΔT: 20F cooling fluid discharge temperate 55F ΔT: 20F

Controls (describe): Temp control T7300 [HVAC 2,6,7] HVAC - controlled by Colder temp

Condition (note date): good

Humidifier

Type: none if biocide is used, note type:

Condition (no overflow, drains trapped, all nozzles working?):

No slime, visible growth, or mineral deposits?

Boilers

Rated Btu input ~600K Condition: good

Combustion air: is there at least one square inch free area per 2,000 Btu input? no

Fuel or combustion odors: none

Cooling Tower

Clean? No leaks or overflow: none Slime or algae growth?

Eliminator performance:

Biocide treatment working (list type of biocide):

Spill containment plan implemented? Dirt separator working?

Chillers

Refrigerant leaks? none

Evidence of condensation problems? _____

Waste oil and refrigerant properly stored and disposed of? _____

Distribution System

		Supply Air		Return Air		Power Exhaust		
Zone/ Room	System Type	Ducted/ unducted	Cfm*	Ducted/ unducted	cftm*	cfm*	Control	Serves (e.g. toilet)

Condition of distribution system and terminal equipment (note locations of problems)

Adequate access for maintenance? _____

Ducts and coils clean and obstructed? _____

Air paths unobstructed? Supply ____ return: ____ transfer: _____ exhaust: make-up: _____

Note locations of blocked air paths, diffusers, or grilles: _____

Any unintentional openings into plenums? _____

Controls operating properly? _____

Filters

Location	Type/Rating	Size	Date last Changed	Condition (give date)
on HVAC	Pre filter	varies	at least once	good
units			a year	

Occupied Space

Thermostat Types: T7300 honeywell

Zone Room	Thermostat Location	What does Thermostat Control? (e.g. radiator, AHU-3)	Setpoints		Measured Temperature	Day/Time
			Summer	Winter		
Labs	1st floor	HVAC 1,2,6,7	70-74	70-74		M-F 7-6pm
OFFICE	1st floor	HVAC 9				AC 9-5-6am
warehouse	1st floor	Gas Heater				only heater

Humidistats/Dehumidistats type: none

Zone/Room	Humidistat/ Dehumidistat Location	What Does it Control?	Setpoints (%RH)	Measured Temperature	Day/Time

Potential problems (note location): _____

Thermal comfort or air circulation (drafts, obstructed airflow, stagnant air, overcrowding, poor thermostat location):

_____

_____

Malfunctioning equipment: _____

Major sources of odors of contaminants (e.g., poor sanitation, incompatible uses of space)

_____

Are there air distribution ducts present? (Yes)/No only BMS Lab, warehouse

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the location on the floor plan diagram.

_____

_____

_____

_____

_____

Part IV – Occupancy

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

Level	General Use of Each Floor (e.g. family room, bedroom, laundry, workshop, storage)
Basement	none
1st Floor	fully occuppied
2nd floor	empty
3rd floor	
4th floor	

Factors that May Influence Indoor Air Quality

a. Is there an attached garage? Y / (N)

b. Does the garage have a separate heating unit? Y/ N/ (NA)

c. Area petroleum-powered machines or vehicles stored in the garage (e.g. lawnmower, atv, car) Y/ N/ (NA) Please specify _____

d. Has the building ever had a fire? Y / (N) When? _____

e. Is a kerosene or unvented gas space heater present? (Y) / N Where? Warehouse / BMS lab

f. Is there a workshop or hobby/craft area? Y / (N) Where & Type? _____

g. Is there smoking in the building? Y / (N) How frequently? _____

h. Have cleaning products been used recently? (Y) / N When & Type?

i. Have cosmetic products been used recently? Y / (N) When & Type? _____

j. Has painting/staining been done in the last 6 months? Y / (N) Where & When? _____

k. Is there new carpet, drapes or other textiles? Y / (N) Where & When? _____

l. Have air fresheners been used recently? Y / (N) When & Type? _____

m. Is there a kitchen exhaust fan? Y / N If yes, where vented? Breakroom exhaust

n. Is there a bathroom exhaust fant? (Y) / N If yes, where vented? _____

o. Is there a clothes dryer? Y / (N) If yes, is it vented outside? Y/N

p. Has there been a pesticide application? Y / (N) When & Type? _____

Are there odors in the building? Y / (N)

If yes, please describe: _____

Do any of the building occupants use solvents at work? (Y) / N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)

If yes, what types of solvents are used? IPA, Acetone

If yes, are there clothes washed at work? Y / (N)

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly) No
Yes, use dry-cleaning infrequently (monthly or less) (Unknown)
yes, work at a dry-cleaning service

Is there a radon mitigation system for the building/structure? Y (N) Date of Installation: _____

Is the system active or passive? Active/Passive N/A

PART V – OUTSIDE CONTAMINANT SOURCES

Known contaminated site (1,000-ft. radius): _____

Other stationary sources nearby (gas stations, emission stacks, etc.): _____

Heavy vehicular traffic nearby (or other mobile sources) and distance from building: _____

PART VI – MISCELLANEOUS ITEMS

Do any occupants of the building smoke? (Yes) / No How often? unknown

Last time someone smoked in the building? N/A Hours / c

Does the building have an attached garage directly connected to living space? Yes / (No)

If so, is a car usually parked in the garage? Yes / No

Are gas-powered equipment or cans of gasoline/fuels stored in the garage? Yes / (No)

Do the occupants of the building have their clothes dry cleaned? (Yes) / No

If yes, how often? Weekly / monthly / 304 times a year unknown

Do any of the occupants use solvents in work? (Yes) / No

If yes, what types of solvents are used? IPA, Acetone

If yes, are their clothes washed work? Yes / (No)

Have any pesticides/herbicides been applied around the building or in the yard? Yes / (No)

If so, when and which chemicals? _____

Has there ever been a fire in the building? Yes / (No) If yes, when? _____

Has painting or staining been done in the building in the last 6 months? Yes / (No)

If yes, when _____ and where? _____

Additional Notes: _____

_____

_____

_____

_____

PART VII – INDOOR CONTAMINANT SOURCES

Identify all potential indoor sources found in the building (including attached garages), the location of the source (floor and room), and whether the item was removed from the building 48 hours prior to indoor air sampling event. Any ventilation implemented after removal of the items should be completed at least 24 hours prior to the commencement of the indoor air sampling event.

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
Gasoline storage cans	✓		
Gas-powered equipment	✓		
Kerosene storage cans			
Paints / thinners / strippers	✓		
Cleaning solvents	✓		
Oven cleaners			
Carpet / upholstery	✓		

Potential Sources	Brand Name	Location(s)	Removed (yes / No / NA)
cleaners			
Other house cleaning products	✓		
Moth balls			
Polishes / waxes	✓		
Insecticides			
Furniture / floor polish	✓		
Nail polish / polish remover	✓		
Hairspray	✓		
Cologne / perfume	✓		
Air fresheners			
Fuel tank (inside building)			
Wood stove or fireplace			
New furniture / upholstery			
New carpeting / flooring			
Hobbies – glues, paints, etc.	✓		

Additional Notes: _____

_____

APPENDIX B

STANDARD OPERATING PROCEDURE INSTALLATION AND EXTRACTION OF THE VAPOR PINS™

Standard Operating Procedure Installation and Extraction of the Vapor Pin™

March 16, 2012

Scope:

This standard operating procedure describes the installation and extraction of the Vapor Pin™[1] for use in sub-slab soil-gas sampling.

Purpose:

The purpose of this procedure is to assure good quality control in field operations and uniformity between field personnel in the use of the Vapor Pin™ for the collection of sub-slab soil-gas samples.

Equipment Needed:

- Assembled Vapor Pin™ [Vapor Pin™ and silicone sleeve (Figure 1)] - Because of sharp edges, gloves are recommended for sleeve installation;
- Hammer drill;
- 5/8-inch diameter hammer bit (Hilti™ TE-YX 5/8" x 22" #00206514 or equivalent);
- 1½-inch diameter hammer bit (Hilti™ TE-YX 1½" x 23" #00293032 or equivalent) for flush mount applications;
- ¾-inch diameter bottle brush;
- Wet/dry vacuum with HEPA filter (optional);
- Vapor Pin™ installation/extraction tool;
- Dead blow hammer;
- Vapor Pin™ flush mount cover, as necessary;
- Vapor Pin™ protective cap; and
- VOC-free hole patching material (hydraulic cement) and putty knife or trowel.

Figure 1. Assembled Vapor Pin™.

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) If a flush mount installation is required, drill a 1½-inch diameter hole at least 1¾-inches into the slab.

4) Drill a 5/8-inch diameter hole through the slab and approximately 1-inch into the underlying soil to form a void.

5) Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.

6) Place the lower end of Vapor Pin™ assembly into the drilled hole. Place the small hole located in the handle of the extraction/installation tool over the Vapor

[1] Cox-Colvin & Associates, Inc., designed and developed the Vapor Pin™; a patent is pending.

Pin™ to protect the barb fitting and cap, and tap the Vapor Pin™ into place using a dead blow hammer (Figure 2). Make sure the extraction/installation tool is aligned

Figure 2. Installing the Vapor Pin™.

parallel to the Vapor Pin™ to avoid damaging the barb fitting.

For flush mount installations, unscrew the threaded coupling from the installation/extraction handle and use the

Figure 3. Flush-mount installation.

hole in the end of the tool to assist with the installation (Figure 3).

During installation, the silicone sleeve will form a slight bulge between the slab and the Vapor Pin™ shoulder. Place the protective cap on Vapor Pin™ to prevent vapor loss prior to sampling (Figure 4).

Figure 4. Installed Vapor Pin™.

7) For flush mount installations, cover the Vapor Pin™ with a flush mount cover.

8) Allow 20 minutes or more (consult applicable guidance for your situation) for the sub-slab soil-gas conditions to equilibrate prior to sampling.

9) Remove protective cap and connect sample tubing to the barb fitting of the Vapor Pin™ (Figure 5).

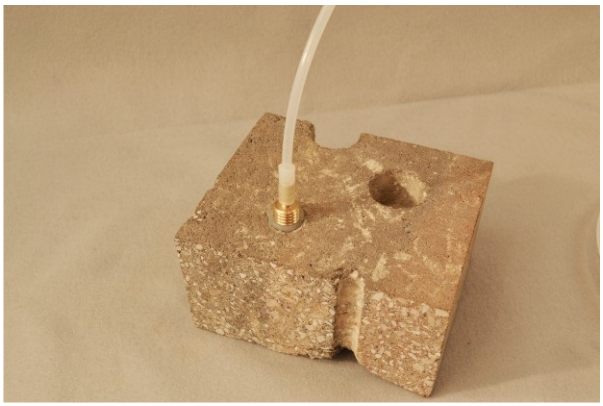


Figure 5. Vapor Pin™ sample connection.

10) Conduct leak tests [(e.g., real-time

monitoring of oxygen levels on extracted sub-slab soil gas, or placement of a water dam around the Vapor Pin™) Figure 6].

Figure 6. Water dam used for leak detection.

Consult your local guidance for possible tests.

11) Collect sub-slab soil gas sample. When finished sampling, replace the protective cap and flush mount cover until the next sampling event. If the sampling is complete, extract the Vapor Pin™.

Extraction Procedure:

1) Remove the protective cap, and thread the installation/extraction tool onto the barrel of the Vapor Pin™ (Figure 7). Continue turning the tool to assist in extraction, then pull the Vapor Pin™ from the hole (Figure 8).

Figure 7. Removing the Vapor Pin™.

Figure 8. Extracted Vapor Pin™.

2) Fill the void with hydraulic cement and smooth with the trowel or putty knife.

3) Prior to reuse, remove the silicone sleeve and discard. Decontaminate the Vapor Pin™ in a hot water and Alconox® wash, then heat in an oven to a temperature of 130° C.

The Vapor Pin™ to designed be used repeatedly; however, replacement parts and supplies will be required periodically. These parts are available on-line at www.CoxColvin.com.

Replacement Parts:

Vapor Pin™ Kit Case - VPC001
Vapor Pins™ - VPIN0522
Silicone Sleeves - VPTS077
Installation/Extraction Tool - VPIE023
Protective Caps - VPPC010
Flush Mount Covers - VPFM050
Water Dam - VPWD004
Brush - VPB026

APPENDIX C

QUALITY ASSURANCE PROJECT PLAN

APPENDIX C
QUALITY ASSURANCE PROJECT PLAN
VAPOR INTRUSION ASSESSMENT
OPERABLE UNIT 1
SANTA CLARA, CALIFORNIA

Prepared For:

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9 April 2014
750620701

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OPERABLE UNIT 1
Santa Clara, California

1.0 PROJECT DESCRIPTION

1.1 Introduction

This Quality Assurance Project Plan (QAPP) specifies analytical methods to be used to confirm that data collected as part of the *Work Plan for Additional On-Property Vapor Intrusion Assessment* (work plan) at the Texas Instruments Incorporated (TI) campus located at 2900 Semiconductor Way in Santa Clara, California (Site) are precise, accurate, representative, comparable, and complete.

1.2 Project Objectives and Problem Definition

The objective of this assessment is to evaluate the vapor intrusion pathway by collecting indoor air, pathway, ambient air and sub-slab vapor samples from on-property buildings with planned occupancy and that have a potential vapor intrusion risk, as requested by the United States Environmental Protection Agency (USEPA) and the California San Francisco Bay Regional Water Quality Control Board (Water Board). The nature and extent of environmental impacts associated with soil and groundwater contamination at the Site have been well defined during previous environmental investigations. The objective of this assessment will be to determine if the vapor intrusion pathway is complete.

The relatively shallow groundwater table, 8 to 15 feet below ground surface, coupled with the moderate volatile organic compound (VOC) concentrations that have been measured at the Site prompted the USEPA and Water Board to require further evaluation of the potential vapor intrusion pathway by collecting indoor air and sub-slab samples. To meet this requirement, Langan Treadwell Rollo (Langan), on behalf of TI, prepared the work plan for *Additional On-Property Vapor Intrusion Assessment* to assess the vapor intrusion potential for constituents of concern in groundwater.

Additional background information for the Site has been provided in Section 1.0 of the work plan.

1.3 Scope of Work

The specific scope of work for this assessment is described in detail in the work plan to which this QAPP is appended. Indoor and ambient air and sub-slab vapor samples will be collected from inside Buildings A, B, C, G, M, W, and 39 located at the Site, in accordance with sampling protocols outlined in the work plan. These samples will be analyzed using the USEPA Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition "Compendium Method TO-15 Determination of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters and Analyzed By Gas Chromatography/ Mass Spectrometry (GC/MS)" (USEPA, 2011).

1.4 Data Quality Objectives and Processes

The quality assurance and quality control (QA/QC) objectives for measurement data include:

- ***Precision*** – an expression of the reproducibility of measurements of the same parameter under a given set of conditions. Field sampling precision will be determined by analyzing coded duplicate samples and analytical precision will be determined by analyzing internal laboratory control sample duplicates.

- ***Accuracy*** – a measure of the degree of agreement of a measured value with the true or expected value of the quantity of concern. Accuracy will be determined by assessing adherence to holding times and the percent recoveries of laboratory control samples.

- ***Representativeness*** – expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness will be determined by assessing a number of investigation procedures, including chain of custody and decontamination, and by assessing measured vacuum on sample containers upon delivery from the laboratory, following sampling, and upon delivery to the laboratory

- ***Completeness*** – the percentage of measurements made which are judged to be valid. The QC objective for completeness is generation of valid data for at least 90% of the analyses requested.

- ***Comparability*** – expresses the degree of confidence with which one data set can be compared to another. The comparability of all data collected for this project will be ensured using several procedures, including standard methods for sampling and analysis, instrument calibrations, using standard reporting units and reporting formats, and data validation.

Each of the above objectives is discussed in detail in Section 3.

To generate data that will meet the project objectives, it is necessary to define the types of decisions that will be made, identify the intended use of the data, and design an appropriate data collection program. Data quality objectives (DQOs) are an integrated set of thought processes that define data quality requirements based on the intended use of the data. DQOs are necessary in order to ensure that data users obtain sufficient data of known defensible quality which fulfill the project goals. Langan has followed the seven-step DQO process, described in the U.S. EPA Guidance on Systematic Planning using the Data Quality Objectives Process (EPA/240/B-06/001)(U.S. EPA, 2006), to determine the quantification, detection, and reporting limits; analytical methods; and sample handling procedures appropriate for this project. The following is a brief description of the seven-step DQO process used in developing the work plan:

Step 1 – Identification of the problem

The objective of this assessment will be to determine if the vapor intrusion pathway is complete by collecting indoor, pathway and ambient air and sub-slab vapor samples from occupied buildings on the TI Santa Clara Campus. The nature and extent of environmental impacts associated with soil and groundwater contamination at the Site have been well defined during previous environmental investigations.

Step 2 – Identification of decisions

Ambient and indoor air sampling results will be used to determine:

- If a groundwater-to-indoor air pathway is complete, and
- If contaminants of concern (COCs) in indoor air pose an unacceptable health risk.

Sub-slab vapor sampling results will be used to assess sub-surface VOC concentrations and to develop site-specific sub-slab-to-indoor air attenuation factors. Based on results of these determinations, further monitoring, engineering control, and/or remedial action may be required.

Step 3 – Identify the inputs to the decision

The following inputs will be used for decision-making:

- Analysis of indoor and ambient air samples for COCs using USEPA-approved procedures modified to achieve lower reporting limits than applicable screening levels;
- Heating, ventilation, and air conditioning (HVAC) operational information;
- Current building structural information such as cracks in floors, basements, crawlspaces, sumps, or locations of piping or conduits penetrating the building foundation;
- Data gathered during the building surveys with the low level photoionization detector;
- The amount of time spent by, and location of, workers in the building;
- Meteorological data gathered from the nearby weather stations; and
- Chemical toxicity data.

Step 4 – Definition of study boundaries

Indoor and ambient air samples will be collected as 10-hour composites for the analysis of the following VOCs:

- trichloroethene (TCE)
- 1,1,1-trichloroethane (1,1,1-TCA)
- cis-1,2-dichloroethene (cis-1,2-DCE)
- 1,1-dichloroethene (1,1-DCE)
- trichlorotrifluoroethene (Freon 113)
- 1,1-dichloroethane (1,1-DCA)
- tetrachloroethene (PCE)
- vinyl chloride
- 1,2-dichloroethane
- cis-1,2-dichloroethene

- trans-1,2-dichloroethene
- chloroethane
- dichloromethane
- 1,1,2-trichloroethane
- chlorobenzene
- 1,2-dichlorobenzene
- 1,4-dichlorobenzene
- trichlorofluoromethane
- chloroform, and
- purgeable aromatics, including ethylbenzene, xylenes and toluene.

These VOCs were detected in groundwater samples during the most recent annual site monitoring event conducted in October 2013 and are also listed in Site Cleanup Requirements Order Number 91-139 (Order), issued on September 20, 1991, by the Water Board. Of these VOCs, PCE, TCE, cDCE, vinyl chloride, 1,1-DCA, and 1,1,-DCE, exceeded Water Board Order cleanup goals in groundwater samples from shallow (A-zone) monitoring wells.

Indoor air, pathway, and sub-slab sampling locations were determined based on previous sampling locations (for Buildings C, G, and 39) and during the site walk with the USEPA and Water Board staff on 21 February 2014 (for Buildings A, B, M, and W). Ambient air samples will be collected from rooftop locations near HVAC units and in the upwind direction as determined by the prevailing wind direction on the sampling day.

Step 5 – Development of decision rules

Decision rules have been broken into two categories:

(1) sampling/data collection, and

(2) health risks.

Decision rules are further discussed below.

(1) Sampling/Data Collection

- If the initial vacuum gauge reads less than 26 inches of Hg, the canister will be replaced prior to sample collection,
- If the final vacuum gauge reads greater than 20 inches of Hg, the sample will be rejected, and
- If sample field duplicate pair results fall within the relative percentage difference of 50%, the results will be considered representative.

(2) Health Risks

Tier 1: Indoor air sample results will be compared to outdoor air concentrations to determine whether indoor air quality may be affected by sources unassociated with vapor intrusion from groundwater.

Tier 2: Indoor air sample results will be compared to short-term health risk based criteria (i.e. Agency for Toxic Substances & Disease Registry [ATSDR] Minimal Risk Levels [MRLs]). If indoor air concentrations exceed these criteria (although it is highly unlikely), immediate confirmatory sampling will be conducted, and if confirmed, appropriate measures will be taken to prevent or reduce levels of exposure.

Tier 3: Indoor air sample results will be compared to long-term health based risk criteria USEPA Regional Screening Levels (RSLs) and Water Board Environmental Screening Levels (ESLs). If indoor air concentrations exceed these criteria, potential indoor and groundwater sources will be evaluated. Slab attenuation factors will be determined and sub-slab data will be adjusted and compared to RSLs and ESLs.

Langan will check the consistency of transfer factors (defined as the ratio of indoor air concentrations and representative groundwater concentrations) among all COCs. These analyses will then be used to decide on whether confirmatory sampling is necessary. If vapor intrusion is determined, mitigation measures may be necessary.

Health risk-based screening criteria are presented below. If indoor air concentrations exceed Tier 2 or Tier 3 criteria, the USEPA and Water Board will be notified within 48 hours of the data

becoming available to Langan. At that time, a call will be scheduled with the Water Board and USEPA to discuss the appropriate follow up action.

Step 6 – Specification of limits on decision errors

Decision Errors: There are two possible decision errors:

Type I Error (False Positives): Determining that a sample contains contaminants exceeding screening levels when it does not, and,

Type II Error (False Negatives): Determining that a sample does not contain contaminants exceeding screening levels when it does.

Decision Error Mitigation: If there actually is a short-term or long-term health risk, but inadequate or incorrect data indicate there is no short term or long-term health risk, worker exposure could exceed levels considered safe. This error could allow short-and/or long-term threats to go undetected. In contrast, if there is no short-term or long-term health risk, but inadequate or incorrect data indicate there is a short-term or long-term health risk; Langan will need to collect additional data and/or mitigate the exposure without sufficient cause.

Decision error resulting in an unmitigated health hazard has more severe consequences, and thus outweighs the consequences of economic costs related to air sampling. Field duplicates, laboratory split samples, and trip blanks will be collected to reduce the risk of sampling and analytical error, and rigorous data review will be performed prior to data submission. Additional sampling rounds can also be used, if appropriate, to reduce the potential for error. Raw data for all samples will be made available for further independent review as required.

Step 7 – Optimization of sampling design for obtaining data

Sampling design is detailed in Section 3.0 of the work plan to which this QAPP is appended. The QA/QC procedures that are to be performed to detect and correct problems and confirm defensible results, are described in the following sections of this report: Section 4.0 – Sampling Program (QA/QC), Section 5.0 – Sample Tracking and Custody, Section 6.0 – Calibration Procedures, and Section 8.0 – Data Validation and Data Usability.

2.0 PROJECT ORGANIZATION

The vapor intrusion assessment will be completed for TI by Langan. Langan will arrange for the sample containers and associated sampling equipment and will provide on-site field representatives to perform the air sampling and sub-slab vapor sampling. Langan will also perform the data analysis and reporting tasks. The VOC analytical services will be performed by a State certified laboratory.

Key contacts for this project are as follows:

Texas Instruments: Site Owner/Representative	Mr. Hector Vargas Telephone: (214) 567-4883
Langan Technical Manager: Consults on project elements and reviews reports prior to submittal to Water Board and USEPA.	Ms. Dorinda Shipman, PG, CHG, ENV SP Telephone: (415) 955-5262
Langan Project Manager: Manages the assessment on a day-to-day basis and coordinates report deliverables.	Mr. Joshua Graber Telephone: (415) 955-5286
Langan Quality Assurance Officer: Reviews project documents for general QA/QC purposes.	Ms. Mukta Patil Telephone: (415) 955-5241
Laboratory Representatives (McCampbell Analytical): Analyze project VOC samples and provides analytical deliverables.	Ms. Jennifer Lagerbom Telephone: (877) 252-9262

3.0 QUALITY ASSURANCE/QUALITY CONTROL – OBJECTIVES FOR MEASUREMENT OF DATA

3.1 Introduction

The QA/QC objectives for all measurement data include precision, accuracy, representativeness, completeness, and comparability. These objectives are defined in following subsections.

3.2 Precision

Precision is an expression of the reproducibility of measurements of the same parameter under a given set of conditions. Specifically, it is a quantitative measurement of the variability of a group of measurements compared to their average value (USEPA, 1987). Precision is usually stated in terms of standard deviation, but other estimates such as the coefficient of variation (relative standard deviation), range (maximum value minus minimum value), relative range, and relative percent difference (RPD) are common.

For this project, field sampling precision will be determined by analyzing coded duplicate samples (labeled so that the laboratory does not recognize them as duplicates) for the same parameters, and then, during data validation (Section 8), calculating the RPD for duplicate sample results.

Analytical precision will be determined by the laboratory by calculating the RPD for the results of the analysis of internal QC duplicates. The formula for calculating RPD is as follows:

$$RPD = \frac{|V_1 - V_2|}{(V_1 + V_2) \div 2} \times 100$$

where:

RPD = Relative Percent Difference.

V_1, V_2 = The two values to be compared.

$|V_1 - V_2|$ = The absolute value of the difference between the two values.

$(V_1 + V_2) \div 2$ = The average of the two values.

The data quality objectives for analytical precision, calculated as the RPD between duplicate analyses, are presented in Table 1.

TABLE 1
QUALITY CONTROL LIMITS FOR AIR SAMPLES

	Analytical Method (a)	MS/MSD (b) % Recovery	MS/MSD RPD I	LCS (d) % Recovery	Surrogate Compounds	Surrogate % Recovery
Volatile Organic Compounds	TO-15	NA	NA	60-140	NA	NA

3.3 Accuracy

Accuracy is a measure of the degree of agreement of a measured value with the true or expected value of the quantity of concern (Taylor, 1987), or the difference between a measured value and the true or accepted reference value. The accuracy of an analytical procedure is best determined by the analysis of a sample containing a known quantity of material, and is expressed as the percent of the known quantity which is recovered or measured. The recovery of a given analyte is dependent upon the sample matrix, method of analysis, and the specific compound or element being determined. The concentration of the analyte relative to the detection limit of the analytical method is also a major factor in determining the accuracy of the measurement. Concentrations of analytes which are close to the detection limits are less accurate because they are more affected by such factors as instrument "noise". Higher concentrations will not be as affected by instrument noise or other variables and thus should be more accurate. Accuracy may also be evaluated by assessing adherence to laboratory holding times.

Sampling accuracy may be determined through the assessment of the analytical results of field blanks and trip blanks for each sample set. Analytical accuracy is typically assessed by examining the percent recoveries of surrogate compounds that are added to each sample (organic analyses only), and the percent recoveries of matrix spike compounds added to selected samples and laboratory blanks. Additionally, initial and continuing calibrations must be performed and accomplished within the established method control limits to define the instrument accuracy before analytical accuracy can be determined for any sample set.

Accuracy is normally measured as the percent recovery (%R) of a known amount of analyte, called a spike, added to a sample (matrix spike) or to a blank (blank spike). The %R is calculated as follows:

$$\%R = \frac{SSR - SR}{SA} \times 100$$

where:

$\%R$ = Percent recovery.

SSR = Spike sample result: concentration of analyte obtained by analyzing the sample with the spike added (measured).

SR = Sample result: the background value, i.e., the concentration of the analyte obtained by analyzing the sample (measures).

SA = Spiked analyte: concentration of the analyte spike added to the sample (known).

For this project, accuracy will be determined by assessing percent recoveries of laboratory control samples. The acceptance limits for accuracy for each parameter are presented in Tables 1 and 2.

3.4 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter which is most concerned with the proper design of the sampling program (USEPA, 1987). Samples must be representative of the environmental media being sampled. Selection of sample locations and sampling procedures will incorporate consideration of obtaining the most representative sample possible.

Field and laboratory procedures will be performed in such a manner as to ensure, to the degree that is technically possible, that the data represents the in-place quality of the material sampled. Every effort will be made to ensure chemical compounds will not be introduced into the sample via sample containers, handling, and analysis. Decontamination of sampling devices and digging equipment will be performed between samples. Analysis of vacuum levels will also be performed to monitor for potential sample contamination from field and laboratory procedures.

The assessment of representativeness also must consider the degree of heterogeneity in the material from which the samples are collected. Sampling heterogeneity will be evaluated during data validation through the analysis of coded field duplicate samples. The analytical laboratory will also follow acceptable procedures to assure the samples are adequately homogenized prior to taking aliquots for analysis, so the reported results are representative of the sample received.

Chain-of-custody procedures will be followed to document that contamination of samples has not occurred during container preparation, shipment, and sampling. Details of duplicate and Chain-of-custody procedures are presented in Sections 4 and 5.

3.5 Completeness

Completeness is defined as the percentage of measurements made which are valid (USEPA, 1987). The QC objective for completeness is generation of valid data for at least 90 % of the analyses requested. Completeness is defined as follows for all sample measurements:

$$\%C = \frac{V}{T} \times 100$$

where:

$\%C$ = Percent completeness.

V = Number of measurements judged valid.

T = Total number of measurements.

3.6 Comparability

Comparability expresses the degree of confidence with which one data set can be compared to another (USEPA, 1987). The comparability of all data collected for this project will be ensured by:

- Using identified standard methods for both sampling and analysis phases of this project;
- Requiring traceability of all analytical standards and/or source materials to the USEPA or National Institute of Standards and Technology (NIST);
- Requiring that all calibrations be verified with an independently prepared standard from a source other than that used for calibration (if applicable);
- Using standard reporting units and reporting formats including the reporting of QC data; and

These steps will ensure all future users of either the data or the conclusions drawn from them will be able to judge the comparability of these data and conclusions.

4.0 SAMPLING PROGRAM QA/QC

4.1 Introduction

The sampling program will provide data concerning the presence of contaminants of concern in indoor, pathway and ambient air and/or sub-slab vapor, if any. This section presents sample container preparation procedures, sample preservation procedures, sample holding times, and field QC sample requirements. Samples type, and the number of environmental and QC samples to be taken are presented in the work plan. The number and location of samples were determined and agreed upon during the building walkthrough surveys by the TI's representatives, the USEPA and the Water Board. The sampling procedures are presented in the work plan.

4.2 Sample Container Preparation, Sample Collection, and Sample Preservation

Sample containers will be properly decontaminated prior to their use by either the analytical laboratory or the container vendor to the specifications required by the USEPA. Copies of the sample container QC analyses will be provided by the laboratory for each container lot used to obtain samples. Summa canisters will be used to collect indoor, pathway, ambient air, and sub-slab vapor samples. The summa canisters will be provided by the project laboratory clean and under vacuum.

Summa canisters will be kept in a secure area on Site. Air samples do not require preservation and will be delivered to the project laboratory at ambient air temperatures. Samples will be picked up from the Site by a laboratory courier and delivered to the laboratory for analysis. Chain-of-custody procedures are described in Section 5.

4.3 Sample Laboratory Holding Times

The sample holding times for organic parameters are given in Table 2 and will be in accordance with the method requirements. The holding times will be adhered to by the laboratory. Any holding time exceedances will be reported to Langan and the data will be qualified.

4.4 Field QC Samples

The precision of field sampling procedures will be assessed by collecting coded field duplicates. The duplicates will consist of:

a. Coded Field Duplicate - To determine the representativeness of the sampling methods, coded field duplicates will be collected. The samples are termed "coded" because they will be labeled in such a manner that the laboratory will not be able to determine that they are a duplicate sample. This will eliminate any possible bias that could arise.

In addition, the USEPA may also choose to collect Performance Evaluation (PE) samples located adjacent to existing sample locations for performance evaluation purposes. The PE samples will be spiked with known concentrations of chemicals of concern. The PE samples, if collected, will be submitted to the project laboratory along with the primary samples to assess the precision and/or accuracy of the laboratory.

TABLE 2
SUB-SLAB AND AIR CONTAINERIZATION, PRESERVATION, AND HOLDING TIMES

Analysis	USEPA Method	Container Type	Preservation	Holding Time [(b)]
Volatile Organic Compounds	TO-15	SUMMA canister[(a)]	Ambient temperature	14 days

[(a)] The laboratory must provide the following equipment certified as clean: Cleaned and evacuated SUMMA canisters with the manufacturer's serial number, or a unique permanent identification number attached.

[(b)] Days from validated time of sample receipt.

5.0 SAMPLE TRACKING AND CUSTODY

5.1 Introduction

This section presents sample custody procedures for both the field and laboratory. Implementation of proper custody procedures for samples generated in the field is the responsibility of field personnel. Both laboratory and field personnel involved in the chain-of-custody and transfer of samples will be trained as to the purpose and procedures prior to implementation.

Evidence of sample traceability and integrity is provided by COC procedures. These procedures document the sample traceability from the selection and preparation of the sample containers by the laboratory, to sample collection, to sample shipment, to laboratory receipt and analysis. The sample custody flowchart is shown in Figure 1. A sample is considered to be in a person's custody if the sample is:

- In a person's possession;
- Maintained in view after possession is accepted and documented;
- Locked and tagged with Custody Seals so that no one can tamper with it after having been in physical custody; or

In a secured area which is restricted to authorized personnel.

5.2 Field Sample Custody

An example COC record (Figure 2) accompanies the sample containers during preparation at the laboratory shipment to the field, sample containment and preservation, and during return to the laboratory. Triplicate copies of the COC must be completed for each sample collected.

The COC lists the field personnel responsible for taking samples, the project name and number, the name of the analytical laboratory to which the samples are sent, and the method of sample shipment. The COC also lists a unique description of every sample container in the set. If samples are split and sent to different laboratories, a copy of the COC record will be sent with each sample.

The 'remarks' space on the COC is used to provide any additional sample information for the laboratory. Once all sampling canisters and manifolds are properly accounted for on the form, a sampler will write his or her signature and the date and time on the first 'relinquished by' space. The sampler will also write the method of shipment, and the shipper air bill number on the top of the COC. Mistakes will be crossed out with a single line in ink and initialed by the author.

One copy of the COC is retained by sampling personnel (notations identifying blind duplicate samples will be added to this copy of the COC but not the others that will go to the laboratory) and the other two copies are put into a sealable plastic bag and placed inside the summa canisters' shipping box. It is then relinquished by field personnel to the laboratory courier, or to

the personnel responsible for shipment, typically an overnight carrier. The COC seal must be broken to open the container. Breakage of the seals before receipt at the laboratory may indicate tampering. If tampering is apparent, the laboratory will contact the Project Manager, and the samples will not be analyzed.

FIGURE 1

SAMPLE CUSTODY

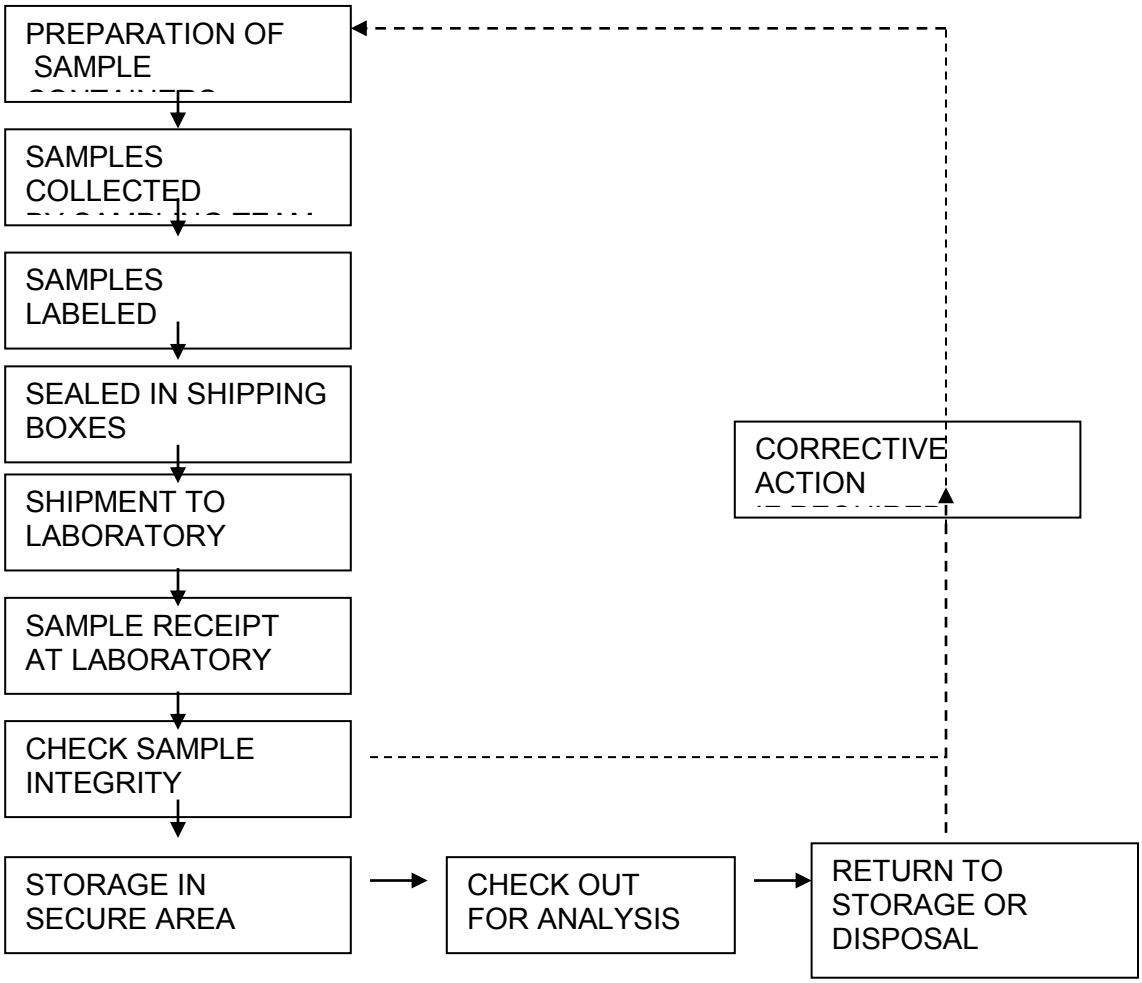
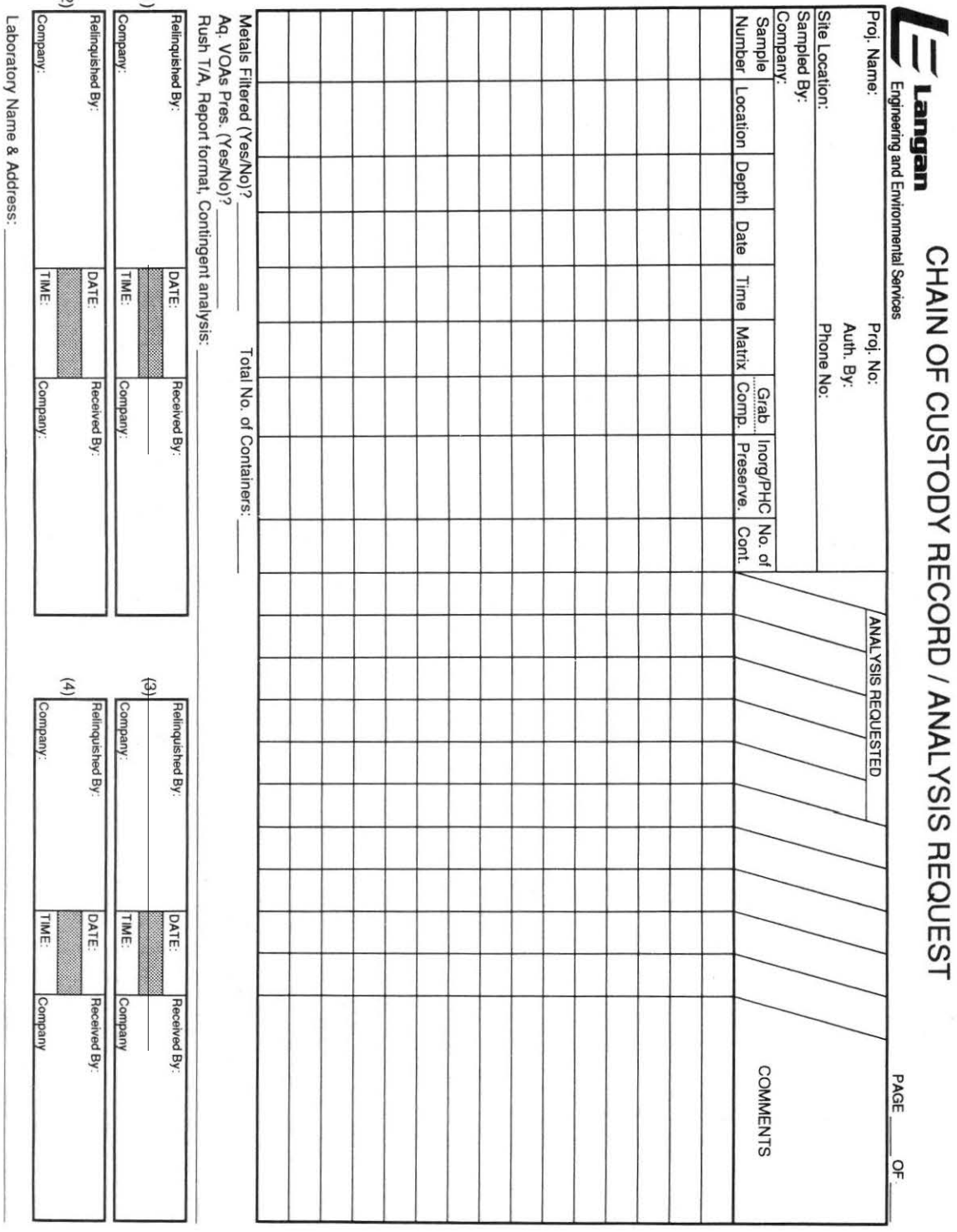


FIGURE 2 CHAIN-OF-CUSTODY RECORD



5.3 Laboratory Sample Custody

The Project Manager or Field Team Leader will notify the laboratory of upcoming field sampling activities, and the subsequent shipment of samples to the laboratory. This notification will include information concerning the number and type of samples to be shipped as well as the anticipated date of arrival.

The following laboratory sample custody procedures will be used:

- The laboratory will designate a sample custodian who will be responsible for maintaining custody of the samples, and for maintaining all associated records documenting that custody.
- Upon receipt of the samples, the custodian will check the original chain of custody documents and compare them with the labeled contents of each sample container for correctness and traceability. The sample custodian will sign the chain of custody record and record the date and time received.
- Care will be exercised to annotate any labeling or descriptive errors. In the event of discrepant documentation, the laboratory will immediately contact the Project Manager or Field Team Leader as part of the corrective action process. A qualitative assessment of each sample container will be performed to note any anomalies, such as broken or leaking bottles. This assessment will be recorded as part of the incoming chain-of-custody procedure.
- The samples will be stored in a secured area at ambient temperature until analyses commence.
- A laboratory tracking record will accompany the sample or sample fraction through final analysis for control.
- A copy of the tracking record will accompany the laboratory report and will become a permanent part of the project records.

6.0 CALIBRATION PROCEDURES

6.1 Field Instruments

All field analytical equipment will be calibrated prior to each day's use. The calibration procedures will conform to manufacturer's standard instructions. This calibration will ensure that the equipment is functioning within the allowable tolerances established by the manufacturer and required by the project. Records of all instrument calibration will be

maintained by the Field Team Leader. Copies of all the instrument manuals will be maintained on-site by the Field Team Leader.

Calibration procedures for instruments used for monitoring health and safety hazards (e.g., photoionization detector) are provided in the Health and Safety Plan.

6.2 Laboratory Instruments

The laboratory will follow all calibration procedures and schedules as specified in the sections of the USEPA TO-15 and subsequent updates that apply to the instruments used for the analytical methods given in Section 7.

7.0 ANALYTICAL METHODS

Samples will be analyzed according to the USEPA TO-15. The Calscience Environmental Laboratories Inc. (Calscience) Standard Operating Procedure (SOP) and TO-15 methodology is attached to this QAPP as Attachment A. The SOP presents information that is considered confidential by Calscience and cannot be presented publically in this document. This confidential SOP (Attachment A) of this QAPP is retained in the Water Board files. For inquiries, please contact: Mr. Max Shahbazian of San Francisco Regional Water Quality Control Board, Telephone (510) 622-4824 and reference Case # 43S0084. Specific analytical methods, reporting limits and screening level limits are listed in Table 2, Screening Criteria for Comparison of Indoor Air Results, of the work plan to which this QAPP is appended.

8.0 DATA VALIDATION AND DATA USABILITY

Data collected during the field investigation will be reviewed by the laboratory QA personnel, and a report on the findings will be tabulated in a standard format. The criteria used to identify and quantify the analytes will be those specified for the applicable methods in the USEPA TO-15 and subsequent updates. The data package provided by the laboratory will contain all items specified in the USEPA TO-15 appropriate for the analyses to be performed. The completed copies of the chain-of-custody records (both external and internal) accompanying each sample from time of initial bottle preparation to completion of analysis shall be attached to the analytical reports.

Data validation processes, which are an integral part of the QA program, consist of reviewing and assessing the quality of data. For validity, the characteristics of importance are precision, accuracy, representativeness, comparability, and completeness. Data usability describes whether a dataset is sufficiently complete and of sufficient quality to support a decision or action in terms of the specific DQOs.

All analytical data submitted by the laboratories will be validated, and, if necessary, exception reports will be produced. Final validated (and qualified, if required) results will be saved to the Project folder. The data validation process, consistent with USEPA Region 9 Tier 2 (USEPA, 2002), includes:

- Evaluating against accuracy criteria — holding times, surrogates, and laboratory control samples;
- Evaluating against precision criteria —field and laboratory duplicates; and
- Confirming that data qualifiers are assigned appropriately.

The USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (U.S. EPA, 2008) will be used for guidance.

Each electronic deliverable will be formatted and copied using an operating system compatible to both Langan and the laboratory. To avoid transcription errors, data will be loaded directly from the laboratory information management system (LIMS). All electronic deliverables must also undergo a QC check by the laboratory before delivery. The original data, tabulations, and electronic media are stored in a secure and retrievable fashion.

The Project Manager or Task Manager will maintain close contact with the QA reviewer to ensure all non-conformance issues are acted upon prior to data manipulation and assessment routines. Once the QA review has been completed, the Project Manager may direct the Team Leaders or others to initiate and finalize the analytical data assessment.

9.0 REFERENCES

USEPA, 1986. SW-846 "Test Method for Evaluating Solid Waste," dated November 1986. U.S. Environmental Protection Agency, Washington, D.C.

Taylor, J. K., 1987. Quality Assurance of Chemical Measurements. Lewis Publishers, Inc., Chelsea, Michigan

USEPA, 1987. Data Quality Objectives for Remedial Response Actions Activities: Development Process, EPA/540/G-87/003, OSWER Directive 9355.0-7- U.S. Environmental Protection Agency, Washington, D.C.

USEPA, 1992a. CLP Organics Data Review and Preliminary Review. SOP No. HW-6, Revision #8, dated January 1992. USEPA Region II.

USEPA, 1992b. Evaluation of Metals Data for the Contract Laboratory Program (CLP) based on SOW 3/90. SOP No. HW-2, Revision XI, dated January 1992. USEPA Region II.

ATTACHMENT A

CALSCIENCE ENVIRONMENTAL LABORATORIES INC.
STANDARD OPERATING PROCEDURE FOR EPA METHOD TO-15

This confidential SOP is retained in the Water Board files. For inquiries, please contact: Mr. Max Shahbazian of San Francisco Regional Water Quality Control Board, Telephone (510) 622-4824 and reference Case # 43S0084.

Title : **EPA METHODS TO-14A/15, VOLATILE ORGANIC COMPOUNDS IN AIR BY GAS CHROMATOGRAPHY / MASS SPECTROMETRY (GC/MS) USING SUMMA® CANISTERS OR TEDLAR™ BAGS**

Document No. : SOP-M380
Revision No. : 6.7
Supersedes : 6.6

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PROPRIETARY INFORMATION STATEMENT

Revision 6.7 changes are noted in bold italicized typeface and preceded by a "►" marker.

APPROVED FOR RELEASE BY: _____ 02/10/14
MANAGEMENT **DATE**

_____ 02-10-14
QA DEPARTMENT **DATE**

1. METHOD IDENTIFICATION

1.1. EPA Method TO-14A and EPA Method TO-15, Volatile Organic Compounds in Air by Gas Chromatography / Mass Spectrometry (GC/MS) Using Summa® Canisters or Tedlar™ Bags.

2. APPLICABLE MATRICES

2.1. This method is applicable for air/vapor matrices.

3. DETECTION LIMITS

3.1. The estimated quantitation limits (EQLs) for these methods are approximately 0.5ppbv.

3.1.1. Refer to Appendix 2 for standard TO-15 analyte and the associated reporting and method detection limits.

3.2. The EQLs will be proportionally higher for samples that require dilution.

3.3. Refer to the current revision of SOP-T006, Determination of Detection Limits, for procedure on establishing detection and reporting limits.

4. SCOPE AND APPLICATION

4.1. EPA Methods TO-14A/15 are used to determine the concentrations of a large number of volatile organic compounds (VOCs) having a vapor pressure greater than 10^{-1} Torr at 25°C and 760 mm Hg. Samples are collected in Summa® polished canisters, MiniCan™ canisters, or Tedlar™ bags.

4.1.1. Use of Tedlar™ bags as sample collection media constitutes a modification to the method and is noted in the final report.

4.2. The following compounds are determined by this method:

TO-14A Target List

Dichlorodifluoromethane	1,2-Dichloroethane	Ethylbenzene
Chloromethane	1,1,1-Trichloroethane	p/m-Xylenes
Chloroform	Benzene	Styrene
Vinyl Chloride	Carbon Tetrachloride	1,1,2,2-Tetrachloroethane
Bromomethane	1,2-Dichloropropane	o-Xylene
Chloroethane	trichloroethene	1,3,5-Trimethylbenzene
Trichlorofluoromethane	c-1,3-Dichloropropene	1,2,4-Trimethylbenzene
1,1-Dichloroethene	t-1,3-Dichloropropene	Benzyl Chloride
Methylene Chloride	1,1,2-Trichloroethane	1,3-Dichlorobenzene
Tetrachloroethene	Toluene	1,4-Dichlorobenzene
1,1-Dichloroethane	1,2-Dibromoethane	1,2-Dichlorobenzene

TO-14A Target List (Cont.)

Hexachloro-1,3-Butadiene, Chlorobenzene, 1,2,4-Trichlorobenzene
c-1,2-Dichloroethene, 1,2-Dichloro-1,1,2,2-tetrafluoroethane
1,1,2-Trichloro-1,2,2-Trifluoroethane

TO-15 Target List

Dichlorodifluoromethane	Benzene	Ethylbenzene
Chloromethane	1,1,1-Trichloroethane	p/m-Xylenes
Chloroform	Carbon Tetrachloride	Styrene
Vinyl Chloride	Chlorobenzene	1,1,2,2-Tetrachloroethane
Bromomethane	Carbon Disulfide	o-Xylene
Chloroethane	1,2-Dichloropropane	1,3,5-Trimethylbenzene
Trichlorofluoromethane	trichloroethene	1,2,4-Trimethylbenzene
1,1-Dichloroethene	cis-1,3-Dichloropropene	Benzyl Chloride
Methylene Chloride	trans-1,3-Dichloropropene	1,3-Dichlorobenzene
1,2-Dibromomethane	1,1,2-Trichloroethane	1,4-Dichlorobenzene
1,1-Dichloroethane	Toluene	1,2-Dichlorobenzene
1,2-Dichloroethane	Bromodichloromethane	1, 2,4-Trichlorobenzene
cis-1,2-Dichloroethene	Tetrachloroethene	Hexachloro-1,3-Butadiene
Acetone	Methyl-t-butyl Ether	4-Methyl-2-pentanone
trans-1,2-Dichloroethene	Bromoform	Vinyl Acetate
2-Butanone	Dibromochloromethane	2-Hexanone
1,1,2-Trichloro-1,2,2-Trifluoroethane		4-Ethyltoluene
1,2-Dichloro-1,1,2,2-Tetrafluoroethane		

Additional Calibrated Compounds (by Request):

Acrylonitrile	Ethyl Acetate	Propene
1,3-Butadiene	Ethanol	iso-Propanol
tert-Butyl Alcohol (TBA)	Heptane	Tetrahydrofuran
Cyclohexane	Hexane	1,2,3-Trichloropropane
1,1-Difluoroethane	Methanol	
Diisopropyl Ether (DIPE)	Naphthalene	
1,4-Dioxane	tert-Amyl Methyl Ether (TAME)	
Ethyl-tert-butyl Ether (ETBE)		

4.3. This method is restricted to use by or under the supervision of analysts and supervisors who are experienced in the use of GC/MS and skilled in the interpretation of mass spectra.

5. METHOD SUMMARY

5.1. EPA Methods TO-14A and 15 describe chromatographic procedures that will allow for the separation of volatile organic compounds and their qualitative and quantitative analysis by mass spectrometry. Detection is achieved using a mass selective detector. Method TO-15 is significant in that it extends Method TO-14A capabilities in the following ways.

5.1.1. Method TO-15 requires the use of a GC/MS which results in more scientifically defensible data.

5.1.2. Method TO-15 establishes method performance and quality control criteria for acceptance of data.

5.2. A known volume of sample is directed from the container (Summa® canister, MiniCan™ canisters or Tedlar™ bag) through a solid multi-module (empty trap, tenex, cryofocuser) concentrator. A very minimal portion of the water vapor in the sample may break through the concentrator during sampling. Dry purging the concentrator with helium, while retaining target analytes can further reduce the water content of the sample. Post concentration, the VOCs are thermally desorbed onto a gas chromatographic column for separation. Detection is by mass selective detector.

5.2.1. Use of Tedlar™ bags as a sample collection media constitutes a modification to the method and is noted in the final report.

6. ►DEFINITIONS

6.1. Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents.

6.2. Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

6.3. Batch: Environmental samples, which are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of the same NELAC-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours unless a client specific Quality Assurance Project Plan (QAPP) guidance provides for a lesser time period or a method specific Standard Operating Procedure (SOP) establishes a different time period, not to exceed 24 hours. An analytical batch is composed of prepared environmental samples which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

6.4. Calibration: To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements.

6.5. Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

6.6. Data Reduction: The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form.

6.7. Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.8. Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

6.9. Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system.

6.10. Laboratory Duplicate: Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.

6.11. Limit of Detection (LOD): A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility.

6.12. Limit of Quantitation (LOQ): The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence.

6.13. Method Blank: A sample of a matrix similar to the batch of associated samples that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

6.14. Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

6.15. Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

6.16. Quality Control: The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users.

6.17. Quantitation Limits: Levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported at a specific degree of confidence.

6.18. Raw Data: Any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, including dictated observations, and

recorded data from automated instruments. If exact copies of raw data have been prepared (e.g., tapes which have been transcribed verbatim, data and verified accurate by signature), the exact copy or exact transcript may be submitted.

6.19. Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for QC purposes.

6.20. ***Please refer to the most current revision of the Calscience QSM for a complete list of terms and definitions.***

7. INTERFERENCES

7.1. Performance of this method is restricted to analysts experienced in the use of the instruments and apparatus required in executing this method and interpretation of mass spectra. Each analyst must demonstrate the ability to generate acceptable results and quality control prior to the analysis of billable samples.

7.2. Resulting from widespread concentration levels among various air samples, a TPH pre-determination for the purpose of determining injection volume is performed. This will help minimize instrument contamination.

7.3. Contamination by carryover can occur whenever high and low concentration level samples are analyzed sequentially. Suspected high level samples should be diluted and then analyzed at the end of the sequence to prevent carryover contamination. The analysis of blanks after high concentration samples is encouraged.

7.4. Interference can also occur when "dirty" samples leave residue in the column. The column can be "baked" after such samples.

7.5. The following provides information regarding possible interferences and target analyte anomalies during analytic processing:

7.5.1. Very volatile compounds such as Chloromethane and Vinyl Chloride can display peak broadening and co-elution with other species if the compounds are not delivered to the column in a small volume or carrier gas. Refocusing of the sample after collection on the primary trap, either on a separate focusing trap or at the head of the column, mitigates this problem.

7.5.2. Interferences in canister samples may result from improper use or from contamination of: 1) the canisters themselves due to poor manufacturing, 2) the canister cleaning apparatus, or 3) the sampling or analytical system. Attention to the following details will help to minimize the possibility of contamination of canisters.

7.5.2.1. New canisters should be filled with humidified zero air and then analyzed, after "aging" for 24 hours, to determine cleanliness. Pending analysis, canisters should be stored in a contaminant-free location.

7.5.2.2. Impurities in the calibration dilution gas and carrier gas, organic compounds out-gassing from system components ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system itself must be demonstrated free of contamination by the periodic analysis of humidified zero air blanks.

7.5.3. Best efforts must be taken to maintain the analytical areas free of all contaminants that include target analytes that are common solvents or reagents in other areas of the laboratory. This can be minimized by restricting entry of these solvents or solvent-contaminated items (e.g., laboratory coats) into the VOC laboratory and proper management / maintenance of laboratory ventilation.

7.5.4. Other major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap. The use of non-Polytetrafluoroethylene (PTFE) thread sealants, plastic tubing, or flow controllers with rubber BUNA-N components should be avoided since such materials out-gas organic compounds which will be concentrated in the trap during the purge operation. Analyses of blanks provide information about the presence of contaminants. When potential interfering peaks are noted in blanks, the analyst should locate and remove the source of contamination before proceeding with calibration and analysis.

7.5.5. Special precautions must be taken to analyze for methylene chloride. The analytical and sample storage area should be isolated from all atmospheric sources of methylene chloride. Otherwise, random background levels will result. Since methylene chloride will permeate through PTFE tubing, all gas chromatography carrier gas lines and purge gas plumbing should be constructed from chromatographic grade stainless steel or copper tubing. Laboratory clothing worn by the analyst should be clean since clothing previously exposed to methylene chloride fumes during SVOC extraction procedures may contribute to sample contamination.

7.6. For information related to Summa Canister Cleaning, refer to SOP T-016.

8. SAFETY

8.1. Exposure to hazardous chemicals should be minimized through the use of proper protective equipment and safe laboratory practices as referenced in the current version of Calscience's Health, Safety, and Respiratory Protection Manual. In general, safety glasses and laboratory coats are required to be worn in all designated laboratory areas. Protective gloves shall be worn when handling chemicals.

8.2. The following compounds covered by this method have been tentatively classified as known or suspected human carcinogens: benzene, methylene chloride, chloroform, bromoform, bromodichloromethane, chlorodibromo-methane, and vinyl chloride.

8.2.1. Primary standards of these toxic compounds must be prepared in a hood. A NIOSH/MESA approved toxic gas respirator should be worn when analysts handle high concentrations of these compounds.

8.3. Material Safety Data Sheets (MSDSs) are available for each laboratory standard and reagent chemical. Employees should review and be familiar with the hazards and precautions outlined in the MSDS for all chemicals to be used prior to handling.

9. EQUIPMENT AND SUPPLIES

9.1. Gas Chromatograph:

9.1.1. Agilent 7890A Gas Chromatograph System, Agilent 6890N Gas Chromatograph, or equivalent.

9.2. Mass Spectrometer:

9.2.1. Agilent 5975C Mass Selective Detector (MSD), Agilent 5973Network Mass Selective Detector, or equivalent capable of scanning from 35 to 300 amu every one second or less, using 70 volts nominal electron energy in the EI mode or equivalent. The MSD must be capable of producing a mass spectrum for BFB that meets all of the criteria in Section 12.1 below, when 100ppbv of BFB is injected.

9.3. Instrument Software

9.3.1. Requires a PC based data system or equivalent.

9.3.2. Agilent MSD ChemStation Version E.02.00.493, Agilent MSD ChemStation Version E.02.01.1177, or equivalent equipped with NIST mass spectral library.

9.4. Instrument Maintenance and Troubleshooting

9.4.1. Refer to the current revision of SOP-T066 and instrument hardware and software manuals for instrument maintenance and troubleshooting.

9.4.2. Additional information can be found in the user manual or operating guide for the specific instrument

9.5. Entech 7016 Autosampler or equivalent.

9.6. Entech 7100 Cryogenic Concentrator or equivalent.

9.7. Chromatographic Column:

9.7.1. Restek RTX-1, 60-m × 0.32-mm ID, 1.0-µm film thickness or equivalent.

9.8. Environics Series 2000 Computerized Multi-Component Gas Mixer.

9.9. 2-stage regulators capable of handling pressures up to 4000 psi and 200 psi.

9.10. Stainless steel or inert Teflon tubing with Swagelock fittings, or equivalent.

9.11. Syringes:

9.11.1. Hamilton 702N gas tight Leurlock type w/ on-off valves or equivalent, sizes 1-mL, 2.5-mL, 5-mL, 25-mL, 50-mL, and 100-mL with NIST Traceable Certificate or equivalent documentation.

10. REAGENTS AND STANDARDS

10.1. Reagents

10.1.1. Zero Air

10.1.2. Reagent grade water for humidifying Summa canisters

10.2. Standards

10.2.1. Tuning standard containing 100ppbv of 4-bromofluorobenzene (BFB) in zero air.

10.2.1.1. The tuning standard also contains internal standards and surrogate standards.

10.2.1.2. 100mL of the tuning standard is injected into the concentrator.

10.2.2. Internal and Surrogate standards - 1 canister

10.2.2.1. Internal Standards: Bromochloromethane, Chlorobenzene-d_5 and 1,4-Difluorobenzene each at a nominal concentration of 100ppbv.

10.2.2.1.1. 100mL of Internal/Surrogate standard is injected with every sample, QC sample, and method blank.

10.2.2.2. Surrogates: 1,4-Bromoflurobenzene (also used as the tuning standard), 1,2-Dichloroethane-d_4 and Toluene-d_8 each at a nominal concentration of 100ppbv.

10.2.2.2.1. 100mL of Internal/Surrogate standard is injected with every sample, QC sample, and method blank.

10.2.3. Primary Calibration Standards - 2 canisters

10.2.3.1. Initial Calibration standard containing each target analyte at a nominal concentration of 1000 ppbv.

10.2.4. Working Initial Calibration Standards

10.2.4.1. Three working calibration mixes (1.25, 25 and 50ppbv) are prepared by using the gas mixer. The other standards are made from these three.

10.2.4.1.1. Press RECALL and 04 (or other appropriate number) followed by START or UPDATE on the Environics Series 2000 Computerized Multi-Component Gas Mixer. The Primary standard canisters are hooked up to the gas mixer and are ready for use. Input the appropriate volumes of the

standards and the zero air to make up the working standards.

10.2.4.2. The 50ppbv calibration mix is made by blending 40mL/min with 720mL of zero air in an evacuated canister. Inject 400mL onto the instrument.

10.2.4.2.1. The 100ppbv calibration standard is made by injecting 800mL of the 50ppbv standard onto the instrument.

10.2.4.3. The 25ppbv calibration mix (tert-Butyl Alcohol at 50ppbv, and Ethanol at 200ppbv) is made by blending 20mL/min of each canister with 760mL/min of zero air in an evacuated Summa® canister. Inject 400mL onto the instrument.

10.2.4.3.1. This standard is also used for the daily CCV.

10.2.4.4. The 12.5ppbv standard is made by injecting 200mL of the 25ppbv standard onto the instrument.

10.2.4.5. The 6.25ppbv standard is made by injecting 100mL of the 25ppbv standard onto the instrument.

10.2.4.6. The 1.25ppbv standard is made by blending 50mL of the 25ppbv standard with 950mL of zero air into an evacuated canister.

10.2.4.7. The 0.5ppbv standard is made by injecting 160mL of the 1.25ppbv standard onto the instrument.

10.2.5. Second Source Verification Standard (ICV/LCS) - 1 canister

10.2.5.1. The second source standard is made from a different canister by blending 20mL/min of each second source standard with 760mL/min of zero air in a Summa® canister.

10.2.5.2. Press RECALL 06 (or other appropriate number) followed by START or UPDATE on the Environics Series 2000 Computerized Multi-Component Gas Mixer. The secondary source standard canisters are hooked up to the gas mixer and are ready for use. Input the appropriate volume of the standard and the zero air to make up the working ICV/LCS standard.

10.2.5.3. Attach and fill the evacuated LCS Summa® Canister.

11. SAMPLE COLLECTION, PRESERVATION, CONTAINERS AND HOLDING TIMES

11.1. Air samples are collected in Summa® canisters, MiniCan™ canisters, or Tedlar™ bags by client field personnel.

11.2. Air samples collected in Summa® canisters or MiniCan™ canisters must be analyzed within 30 days of collection. Preservation is not required (store at ambient temperature).

11.2.1. Regulatory agencies may require shorter hold times than 30 days. It is the responsibility of the Calscience Project Manager to relay differing requirements as appropriate.

11.3. Air samples collected in Tedlar™ bags must be analyzed with 3 days of collection. Preservation is not required (store at ambient temperature out of sunlight).

11.3.1. Use of Tedlar™ bags as a sample collection media constitutes a modification to the method and is noted in the final report.

12. ►QUALITY CONTROL

12.1. Hardware Tuning

12.1.1. An acceptable tune demonstrates satisfactory hardware performance. A tune meeting the acceptance criteria is required and MUST be recorded prior to any ICAL, CCV, QC or sample analyses.

12.1.1.1. The stated criteria is used to evaluate the status of the instrument tune for both EPA TO-14 and EPA TO-15. This criteria is reflective of the criteria stated in EPA TO-14A and is stricter than that found in the published EPA TO-15 method.

12.1.2. Prior to running the calibration standard(s) or CCVs, the GC/MS BFB tuning standard must be analyzed and meet the following acceptance criteria:

Mass	Ion Abundance Criteria
50	15 - 40% of mass 95
75	30 - 60% of mass 95
95	Base peak, 100% relative abundance[Note 1]
96	5 - 9% of mass 95
173	< 2% of mass 174
174	> 50% to 120% of mass 95
175	5 - 9% of mass 174
176	Greater 95% but less than 101% of mass 174
177	5 - 9% of mass 176

Note 1: All ion abundances must be normalized to mass 95, the nominal base peak, even though the ion abundance of mass 174 may be up to 120% of mass 95.

12.1.3. These criteria must be demonstrated initially and, at a minimum, every 24 hours thereafter.

12.1.4. If a tune does not meet the acceptance criteria, correct the problem and re-tune the system.

12.1.5. Whenever invasive maintenance of the GC/MS hardware is performed, the system must be re-tuned.

12.2. Initial Calibration

12.2.1. A minimum of a five-point, usually seven-point, initial calibration must be established prior to the processing of samples.

12.2.2. The initial calibration is deemed valid if:

12.2.2.1. The %RSD for the RF for each target analyte is < 30% with, at most, two exceptions up to a limit of 40%.

12.2.2.1.1. EPA Method TO-14A does not allow any exceptions for the method target analyte list.

12.2.2.2. The %RSD for the RRT for each target analyte at each concentration level is within 0.06 RRT units of the mean RRT of the target analyte.

12.2.2.3. The area response at each calibration level is within 40% of the mean area response over the initial calibration range for each internal standard.

12.2.2.4. The retention time shift for each of the internal standards at each calibration level is within 20 seconds of the mean retention time over the initial calibration range for each internal standard.

12.3. Initial Calibration Verification (ICV)

12.3.1. Immediately following establishment of a valid initial calibration, an ICV standard must be analyzed. The ICV is the second source standard used for the LCS/LCSD.

12.3.1.1. The ICV is deemed valid if the %D for each target analyte contained in the standard is ± 30%, with the exception of three analytes, up to ± 40%D. Analytes not contained in the standard (non-method specified, such as ethanol and methanol) are not evaluated in the ICV unless required by client or project.

12.3.1.1.1. Up to three analytes outside of the 30%D criteria but within the 40%D criteria should be noted on the chemists data review sheet as bias high or bias low and the corresponding sample data flagged as needed. Analytes that are not evaluated should also be noted.

12.3.1.2. If these criteria are not met, the ICV/LCS is deemed unacceptable for sample analysis to resume. Reanalyze the ICV/LCS. If the ICV/LCS criteria remain unacceptable, effect corrective action and re-tune/recalibrate. If acceptable, proceed with sample analysis.

12.3.1.3. The internal standard area responses and retention times in the ICV must be evaluated after data acquisition. If the retention time for any internal standard changes by more than 20 seconds from the mean retention time in the initial calibration, the

chromatographic system must be inspected for malfunctions and corrective action must be effected.

12.3.1.4. If the area response for any internal standard changes by ± 40% (Range: 60% to 140%) from the mean area response in the initial calibration, the system must be inspected for malfunctions and corrective action effected. Following corrective action, reanalyze the ICV. If still out, recalibrate.

12.4. Continuing Calibration Verification (CCV)

12.4.1. Following establishment of a valid initial calibration and every 24 hours thereafter, a CCV standard must be analyzed.

12.4.1.1. The CCV is deemed valid if the %D for each target analyte is ≤ 30%.

12.4.1.1.1. Non-method specified compounds are not subject to the ≤ 30%D criteria.

12.4.1.2. If these criteria are not met, the CCV is deemed unacceptable for sample analysis to resume. Reanalyze the CCV. If the CCV criteria remain unacceptable, effect corrective action and re-tune/recalibrate.

12.4.1.3. The internal standard area responses and retention times in the CCV must be evaluated after or during data acquisition. If the retention time for any internal standard changes by more than 20 seconds from the last CCV (24 hours), the chromatographic system must be inspected for malfunctions and corrective action must be effected.

12.4.1.4. If the area response for any internal standard changes by ± 40% (Range: 60% to 140%) from mean area response from the initial calibration, the system must be inspected for malfunctions and corrective action effected. Following corrective action, re-analysis of samples analyzed while the system was malfunctioning is required.

12.4.1.5. If these criteria are not met then all samples analyzed since the last acceptable CCV should be invalidated, corrective action effected, and the affected samples re-analyzed.

12.4.1.5.1. If a failed CCV is the first of the day, corrective action must be effected prior to analyzing any samples.

12.4.1.6. It is a useful diagnostic tool to monitor internal standard retention times and area counts in all samples, spikes, blanks, and standards to check drifting method performance and monitor system trends.

12.5. Event Based Quality Control (MB, BB and LCS/LCSD)

12.5.1. Method Blank (MB)

12.5.1.1. The MB is a Summa canister pressurized with humidified Zero Air that is processed concurrently with the associated samples.

12.5.1.2. In the processing of the MB, surrogates, internal standards and procedures identical to those for actual samples are used.

12.5.1.2.1. One method blank is required every 20 samples. Method blanks on a more frequent basis (e.g., after high concentration samples) is strongly encouraged.

12.5.1.2.2. A MB shall be contained in a Summa® canister used only for MBs. The MB can NEVER be run before a CCV and MUST be run before any samples.

12.5.1.3. Ideally, the concentration of target analytes in a MB should be less than the respective reporting limits (RLs). (Less than ½ the RL for DOD work, and some client specific projects.) If the concentration of any target analyte exceeds its RL, the source of contamination must be investigated and, if possible, eliminated. The acceptance criteria for MBs is as follows:

12.5.1.3.1. If a target analyte is found in the MB but not in the associated samples, report the sample and MB data without qualification.

12.5.1.3.2. If a target analyte is found in the MB and in the associated samples, evaluate the analyte in question to determine the effect on the analysis of samples. Determine and eliminate the source of contamination. Professional judgment should be exercised to determine if the data should be qualified or rejected and the samples re-analyzed.

12.5.1.4. Internal Standard Retention Times (RT) must be ± 0.33 minutes.

12.5.1.5. The area response for each internal standard in the method blank must be within ± 40% (Range: 60% to 140%) of the mean area response of the internal standards in the most recent initial calibration.

12.5.2. Tedlar Bag Blank (BB)

12.5.2.1. Samples received in Summa canisters will often require dilution to account for high levels of hydrocarbons, non-target and target analytes. These dilutions are performed in Tedlar bags.

12.5.2.2. To monitor potential contamination from the Tedlar bags, a Bag Blank (BB) is analyzed. A Summa canister method blank (MB) is analyzed per standard procedure and the bag blank is analyzed as a sample within the batch.

12.5.2.3. The acceptance and reporting criteria for the bag blank are as follows.

12.5.2.3.1. If no target analytes are detected, batch all sample analyses with the MB and file the BB raw data with the QC paperwork.

12.5.2.3.2. If target analytes are detected in the BB but not in the dilution samples, batch all sample analyses with the MB and file the BB raw data with the QC paperwork.

12.5.2.3.3. If target analytes are detected in the BB and in the corresponding sample dilutions, batch the dilutions with the BB and file the BB raw data with the QC paperwork.

12.5.2.3.3.1. Create separate batches for the MB and the BB. Summa analyses are batched with the MB. Tedlar dilutions are batched with the BB. Flag results as needed.

12.5.2.4. Internal Standard Retention Times (RT) must be ± 0.33 minutes.

12.5.2.5. The area response for each internal standard in the method blank must be within ± 40% (Range: 60% to 140%) of the mean area response of the internal standards in the most recent initial calibration.

12.5.3. Lab Control Sample (LCS/LCSD)

12.5.3.1. The LCS is a known gaseous matrix containing a known concentration of specific target analytes (25 ppbv). The purpose of the LCS is to demonstrate that the entire analytical process and systems are in control. The LCSD is a duplicate of the LCS.

12.5.3.1.1. The LCS/LCSD is obtained by injecting 400 mL of the ICV/LCS/LCSD working standard.

12.5.3.2. The LCS/LCSD is processed concurrently with the associated samples. In the processing of the LCS/LCSD, reagents and procedures identical to those for actual samples are used. The LCS/LCSD should be run after the CCV.

12.5.3.2.1. A LCS/LCSD is required for every batch of 20 samples or portion thereof, whichever is more frequent.

12.5.3.3. In addition to assessing the accuracy of the analytical measurement, the LCSD, in combination with the LCS, is used to assess the precision of the analytical process. The measurement is expressed as relative percent difference (RPD). The formula for calculating RPD is listed in Section 15, Calculations.

12.5.3.4. The acceptance criteria for LCS/LCSD compounds vary depending upon historical data. The upper and lower acceptance limits for each LCS/LCSD compound are based upon the historical average recovery ± 3S.

12.5.3.5. All LCS/LCSD compounds must be within the current historical control limits. If one or more LCS/LCSD compounds are not acceptable, the problem must be identified and corrected.

12.5.3.6. Internal Standard Retention Times (RT) must be ± 0.33 minutes.

12.5.3.7. Internal Standard Retention Areas must be ± 40% (Range: 60% to 140%) of initial calibration.

12.5.3.8. The lower and upper acceptance limits for %REC and RPD of each LCS/LCSD compound are based upon the historical average recovery ± 3S that is updated at least annually or based upon client specific project limits.

12.6. Sample Based Quality Control (Surrogates)

12.6.1. The acceptance criteria for surrogate spike compound recoveries vary depending upon historical data. The upper and lower acceptance limits for each surrogate spike compound is based upon the historical average recovery ± 3S and may be periodically revised.

12.6.1.1. If the surrogate compound recoveries are acceptable, report the surrogates and sample data without qualification.

12.6.1.2. If one or more surrogate recoveries are not acceptable, evaluation is not necessarily straightforward. The sample itself may produce effects due to such factors as interferences and high analyte concentration or a problem may have occurred during extraction.

12.6.1.3. The data alone cannot be used to evaluate the precision and accuracy of individual sample analyses. However, when exercising professional judgment, this data should be used in conjunction with other available QC information.

12.6.1.4. By itself, unacceptable surrogate recoveries do not invalidate sample data. The following must be accomplished if surrogate recoveries are not acceptable.

12.6.1.4.1. Check the internal standard and surrogate spiking mixtures for degradation and contamination.

12.6.1.4.2. If the nonconformance is due to poor instrument performance or if the above actions fail to reveal the cause of the unacceptable surrogate(s) recovery, the sample should be re-analyzed.

12.6.1.4.3. If incorrect procedures or degraded/contaminated spiking mixtures are determined to have not caused the unacceptable surrogate recoveries, the affected sample(s) must be re-analyzed or, if insufficient sample remains, reference made to the associated MB surrogate recoveries and the sample data reported with qualification.

12.6.1.4.3.1. If, upon re-analysis, the surrogates remain unacceptable, matrix interference can be cited and reference made to the associated MB surrogate recoveries and the sample data reported with qualification.

12.6.1.4.3.2. If the MB surrogates are unacceptable, all associated sample data must invalidated and all associated samples re-analyzed.

12.6.2. Sample Based Quality Control (Internal Standards)

12.6.2.1. Internal Standard Retention Times (RT) must be ± 0.33 minutes.

12.6.2.2. Internal Standard Retention Areas must be ± 40% (Range: 60% to 140%) of initial calibration.

12.7. Method Detection Limit (MDL)

12.7.1. An MDL must be established prior to the analysis of samples, whenever major instrument changes are made, or annually following the procedures outlined in SOP-T006, Determination of Detection Limits.

12.7.2. The formula for calculating the MDL is listed Section 15.6.

12.7.3. MDLs should be verified immediately following the establishment of the MDL at 1−4x the MDL value for each analyte.

12.7.3.1. MDL's may be verified more frequently as required by project or client requirements.

12.8. Demonstration of Capability

12.8.1. Prior to beginning the analysis, analysts are required to initially demonstrate method competence by generating 4 LCSs that meet the acceptance criteria for the method.

12.8.2. Additionally, analysts are required to generate continuing demonstrations of capability on an annual basis to show continued proficiency in the method.

12.9. Additional information regarding internal quality control checks is provided in SOP-T020.

13. CALIBRATION AND STANDARDIZATION

13.1. Prior to the analysis of samples or QC samples, the GC/MS system must be hardware tuned and an initial seven-point calibration established. The acceptance criteria for the tuning parameters are listed in Section 12.1.

13.2. Tuning

13.2.1. Three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged. Background subtraction is required and must be accomplished using a single scan no more than 20 scans prior to the elution of the BFB. Do not background subtract part of the BFB peak.

13.2.2. Additionally, baseline separation of Benzene and Carbon Tetrachloride is an indication of acceptable chromatographic performance and must be achieved prior to establishment of the calibration. If not, check or replace the column.

13.3. Initial and Continuing Calibration:

13.3.1. An initial seven-point calibration is obtained by injecting 0.5-, 1.25-, 6.25-, 12.5-, 25-, 50-, and 100-ppbv standards into the GCMS.

13.3.1.1. The ICAL is acceptable if the %RSD for the RF for each target analyte is ≤ 30% with the exception of two target analytes, to a limit of ≤ 40%.

13.3.1.2. EPA Method TO-14A does not allow any exceptions for the method target analyte list.

13.3.2. Prior to the analysis of any samples or QC samples and after obtaining an acceptable initial calibration, the ICAL must be verified by the analysis of an Initial Calibration Verification standard (ICV/LCS).

13.3.2.1. The ICV is deemed valid if the %D for each target analyte contained in the standard is ± 30%, with the exception of three analytes, up to ± 40%D. Analytes not contained in the standard (non-method specified analytes) are not evaluated in the ICV.

13.3.3. To verify the continued validity of the ICAL, a continuing calibration verification (CCV) must be analyzed prior to analyzing any QC or samples. This is done daily at the start of each batch, following the tuning standard.

13.3.3.1. The CCV is deemed valid if the %D for each target analyte is ± 30%.

14. PROCEDURE

14.1. Samples should be loaded in the following order:

- Tuning Standard
- Continuing Calibration Verification (CCV)
- Laboratory Control Sample (LCS)
- LCS Duplicate (LCSD)
- Method Blank (MB)
- Samples (up to 20)

14.2. Perform preliminary screening of the samples via TO-3 (M) analysis. This is not necessary for samples known to be fairly clean or if there is historical data available.

14.2.1. Summa® canisters may need to be pressurized prior to analysis, reference SOP-T016 for pressurization procedures.

14.2.2. Calculate and perform dilutions as needed using the gas mixer and syringes for non-chlorinated samples based upon screening level found i.e., target the diluted TPH (G) to be bracketed thusly: 3.5 ppmv < Diluted TPH (G) level < 4 ppmv.

14.3. Attach the samples to the autosampler "tree". Use inert Teflon tubing for Tedlar™ bags. Hang and use metal Swage-type connections for Summa® canisters or use quick-connect fittings for MiniCan™ canisters.

14.4. Edit the sequence in the data system. After all correct sample information is entered, save the sequence. After saving the sequence, record pertinent information in the run logbook.

14.5. Initiate the sequence.

14.6. Data Interpretation

14.6.1. The qualitative identification of analytes determined by this method is based on the 1) elution of the sample component at the same relative retention time (RRT) as the standard component and 2) comparison of the sample mass spectrum, after background correction if necessary, with characteristic ions in a reference mass spectrum. The reference mass spectrum should be obtained from the GC/MS within the same 24 hour period as the sample analysis.

14.6.2. The characteristic ions from the reference mass spectrum are defined as the three ions of greatest relative intensity, or any ions over 30% relative intensity if less than three such ions occur in the reference spectrum.

14.6.3. Target analytes should be identified as present when:

14.6.3.1. The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other. Selection of a peak by a data system target compound search routine where the search is based on the presence of a target chromatographic peak containing ions specific for the target

analyte at a compound-specific retention time will be accepted as meeting this criterion.

14.6.3.2. The RRT of the sample target analyte is within ± 0.06 RRT units of the RRT of the standard target analyte.

14.6.3.3. The relative intensities of the characteristic ions agree within 30% of the relative intensities of these ions in the reference spectrum.

14.6.3.4. Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different retention times. Sufficient resolution is achieved if the height of the valley between two isomer peaks is less than 25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

14.6.3.5. Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one target analyte. When gas chromatographic peaks obviously represent more than one sample component, appropriate selection of analyte spectra and background spectra is important. Examination of extracted ion current profiles (EICPs) of appropriate ions can aid in the selection of spectra and in qualitative identification of compounds. When analytes co-elute, the identification criteria can be met, but each analyte spectrum will contain extraneous ions contributed by the co-eluting compound.

14.6.4. When a compound has been identified, the quantitation of the compound will be based on the integrated abundance of the primary characteristic ion. Quantitation will take place using the internal standard technique. The internal standard used shall be the one nearest the retention time of that of a given analyte.

14.6.4.1. Identify and compute the concentration of each target analyte in the sample. The GC/MS data system should be programmed to perform these functions. The details provided in the below subsections are for the purpose of understanding and data system programming.

14.6.4.2. Upon request, a library search may be made for the purpose of tentative identification of compounds not associated with the calibration standards. Refer to SOP-T025.

14.6.5. Manual integration of peaks shall adhere to the procedures and documentation policies outlined in the current revision of SOP-T023.

15. CALCULATIONS

15.1. The response factor is calculated as follows:

$$RF = \frac{A_x \times C_{is}}{A_{is} \times C_x}$$

where: RF = response factor for target analyte being measured.
A_x = area of the characteristic ion for target analyte being measured.
C_{is} = concentration of internal standard in ng/µL.
A_{is} = area of the characteristic ion for internal standard.
C_x = concentration of target analyte being measured in ng/µL.

15.2. The percent relative standard deviation is calculated as follows:

$$\%RSD = \frac{SD}{RF_{ave}} \times 100$$

where: %RSD = percent relative standard deviation.
SD = standard deviation of the RFs for the target analyte.
RF_{ave} = mean of the 5 initial RFs for the target analyte.

15.3. The relative retention time of each target analyte is calculated as follows:

$$RRT = \frac{RT_x}{RT_{is}}$$

where: RRT = relative retention time of target analyte.
RT_x = retention time of target analyte.
RT_{is} = retention time of internal standard.

Note: Retention times are in minutes to three decimal places.

15.4. The relative percent difference is calculated as follows:

$$RPD = \frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2}\right)} \times 100$$

where: RPD = relative percent difference between two measurements (C_1 and C_2).
C_1 = concentration of target analyte in measurement 1.
C_2 = concentration of target analyte in measurement 2.

Note: Concentrations must be in equivalent units.

15.5. The recovery of each LCS compound is calculated as follows:

$$\%REC_{LCS} = \frac{C_{recovered}}{C_{added}} \times 100$$

where: $\%REC_{LCS}$ = percent recovery of target analyte in LCS (or LCSD).
$C_{recovered}$ = concentration of target analyte recovered.
C_{added} = concentration of target analyte added.

Note: Concentrations must be in equivalent units.

15.6. Refer to SOP-T006 for MDL calculations.

16. METHOD PERFORMANCE

16.1. A demonstration of analytical capability shall be performed initially (prior to the analysis of any samples) and with a significant change in instrument type, personnel, matrix or test method.

16.2. Calibration protocols specified in Section 13, "Calibration and Standardization," shall be followed.

17. POLLUTION PREVENTION

17.1. The toxicity, carcinogenicity and other health hazards associated with the use of most laboratory chemicals have not been precisely defined. Each chemical should be handled assuming it is a potential health hazard.

17.2. Exposure to these chemicals should be minimized through the use of proper protective equipment and safe laboratory practices as referenced in the current revision of Calscience's Health, Safety, and Respiratory Protection Manual. In general, safety glasses, lab coats and gloves are required to be worn when handling chemicals.

17.3. The following additional precautions should be taken, as necessary, when handling high concentrations of hazardous materials:

17.3.1. A NIOSH approved air purifying respirator with cartridges appropriate for the chemical handled.

17.3.2. Extended length protective gloves.

17.3.3. Face shield.

17.3.4. Full-length laboratory apron.

17.4. Processes that promote vaporization of volatile chemicals should be performed in an area well ventilated to the exterior of the laboratory to prevent contamination to other areas in the laboratory.

17.5. When working with large amounts of volatile chemicals, the Coordinator must be cautious of the risk of high levels of volatile displacing the atmospheric air within the work area; therefore causing asphyxiation. Air purification respirators are ineffective in this situation and must not be used. The Coordinator must immediately vacate the area until ventilation has effectively reduced the concentration of volatiles. Alternatively, the Coordinator may utilize a self-contained breathing apparatus or other supplied air system if appropriately trained and approved by the Health and Safety Manager.

18. DATA ASSESSMENT AND ACCEPTANCE CRITERIA

18.1. Method Blank

18.1.1. Ideally, the concentration of target analytes in a MB should be less than the respective reporting limits (RLs). (Less than ½ the RL for DOD work, and some client specific projects.) If the concentration of any target analyte exceeds its RL, the source of contamination must be investigated and, if possible, eliminated. The acceptance criteria for MBs is as follows:

18.1.1.1. If a target analyte is found in the MB but not in the associated samples, report the sample and MB data without qualification.

18.1.1.2. If a target analyte is found in the MB and in the associated samples, evaluate the analyte in question to determine the effect on the analysis of samples. Determine and eliminate the source of contamination.

18.1.1.3. Professional judgment should be exercised to determine if the data should be qualified or rejected and the samples re-extracted and/or re-analyzed.

18.2. LCS/LCSD

18.2.1. The lower and upper acceptance limits for %REC and RPD of each LCS/LCSD compound are based upon the historical average recovery ± 3S that is updated at least annually or based upon client specific project limits.

18.2.2. All LCS/LCSD compounds must be within acceptance limits. If one or more LCS/LCSD compounds are not acceptable, the problem must be identified and corrected.

18.2.3. If the LCS and/or LCSD %REC is outside of the acceptance limits high, the RPD is within acceptance limits, and all target analytes in the associated samples are not detected, the sample data can be reported without qualification.

18.3. Internal Standards

18.3.1. Internal Standard Retention Times (RT) for Bromochloromethane, Chlorobenzene-d_5 and 1,4-Difluorobenzene in all samples and QC must be ± 0.33 minutes.

18.3.2. The area response for each internal standard in all samples and QC must be within ± 40% (Range: 60% to 140%) of the mean area response of the internal standards in the most recent initial calibration.

18.4. Surrogates

18.4.1. The acceptance criteria for surrogate spike compound recoveries vary depending upon historical data. The upper and lower acceptance limits for each surrogate spike compound is based upon the historical average recovery ± 3S and may be periodically revised.

18.4.2. If the surrogate compound recoveries are acceptable, report the surrogates and sample data without qualification.

18.4.3. If one or more surrogate recoveries are not acceptable, evaluation is not necessarily straightforward. The sample itself may produce effects due to such factors as interferences and high analyte concentration. This data alone cannot be used to evaluate the precision and accuracy of individual sample analyses. However, when exercising professional judgment, this data should be used in conjunction with other available QC information.

18.4.4. By itself, unacceptable surrogate recoveries do not invalidate sample data. The following must be accomplished if surrogate recoveries are not acceptable.

18.4.4.1. Check the internal standard and surrogate spiking mixture for degradation and contamination.

18.4.4.2. If the nonconformance is due to poor instrument performance or if the above actions fail to reveal the cause of the unacceptable surrogate(s) recovery, the same sample or extract should be re-analyzed.

18.4.4.3. If incorrect procedures or degraded/contaminated spiking solutions are determined to have not caused the unacceptable surrogate recoveries, the affected sample(s) must be re-analyzed or, if insufficient sample remains, reference made to the associated MB surrogate recoveries and the sample data reported with qualification.

18.4.4.3.1. If, upon re-analysis, the surrogates remain unacceptable, matrix interference can be cited and reference made to the associated MB surrogate recoveries and the sample data reported with qualification.

18.4.4.3.2. If the MB surrogates are unacceptable, all associated sample data must be invalidated and all associated samples re-analyzed.

18.5. Additional information regarding internal quality control checks is provided in SOP-T020.

18.6. All concentrations shall be reported in ppb(v/v).

18.6.1. Units may be reported in ppm(v/v), µg/L or µg/m^3 on a project specific basis.

18.7. The data reported shall adhere to the significant figures, rounding, and data reporting procedures outlined in the current revision of SOP-T009.

19. CORRECTIVE ACTIONS

19.1. If on the basis of internal or external systems or performance audits, routine monitoring of laboratory support equipment, or QC sample analysis results, analytical systems fail to meet the established criteria, an appropriate corrective action must be implemented.

19.2. The Operations Manager, Project Manager, Quality Control Manager, Group Leader and analyst may be involved in identifying the most appropriate corrective action. If previously reported data are affected or if corrective action will impact the project budget or schedule, the action may directly involve the Laboratory Director.

19.3. Corrective actions are generally of two types, immediate and long-term actions.

19.3.1. An **immediate action** is designed to correct or repair nonconforming instruments and measurement systems. The analyst or Group Leader as a result of calibration checks and other QC sample analyses most frequently will identify the need for such an action.

19.3.2. A **long-term action** is designed to eliminate causes of nonconformance. The need for such actions is identified by systems and performance audits. The systematic nonconformances identified during the data generation process and the appropriate corrective measures taken are thoroughly documented in the Corrective Action Record. Examples of this type of action include:

19.3.2.1. Remedial training of staff in technical skills, technique or implementation of operating procedures.

19.3.2.2. Rescheduling of analytical laboratory routine to ensure analysis within holding times.

19.3.2.3. Revision of standard operating procedures.

19.3.2.4. Replacing personnel, as necessary.

19.4. For either type of corrective action, the sequential steps that compose a close-loop corrective action system are as follows:

19.4.1. Define the problem.

19.4.2. Assign responsibility for investigating the problem.

19.4.3. Investigate and determine the cause of the problem.

19.4.4. Assign and accept responsibility for implementing the corrective action.

19.4.5. Determine effectiveness of the corrective action and implement correction.

19.4.6. Verify that the corrective action has eliminated the problem.

19.5. Depending on the nature of the problem, the corrective action employed may be formal or informal. In either case, occurrence of the problem, the corrective action employed, and verification that the problem has been eliminated must be properly documented on a Corrective Action Record.

20. CONTINGENCIES FOR OUT-OF-CONTROL OR UNACCEPTABLE DATA

20.1. Out-of-control data are reviewed and verified by the group leader of the appropriate department. All samples associated with an unacceptable QC set are then subject to reanalysis, depending upon the QC type in question.

20.1.1. LCS/LCSD: Because they denote whether the analytical system is operating within control, it is imperative that the LCS recoveries obtained are within acceptability criteria. If the recoveries fail for a given reported compound, the technical director confirms the unacceptable result.

20.1.1.1. If the LCS results are verified as acceptable, no corrective action is required.

20.1.1.2. If the LCS result is verified as out-of-control, and the subject compound is to be reported in samples within that analytical batch, the samples reported with that failed compound must be reanalyzed with a valid LCS recovery for the compound.

20.1.1.3. If the LCS result is verified as out-of-control, and the subject compound is NOT to be reported in the samples within that analytical batch, the samples are not subject to reanalysis. No corrective action is required for that batch.

21. WASTE MANAGEMENT

21.1. The proper disposal of analytical samples and laboratory wastes is not only good laboratory practice, but also regulated by a variety of local, state, and federal laws. In order to remain compliant with these laws, and at the same time keep sample disposal costs at a minimum, the samples and wastes are identified, segregated, and either returned to the client (preferable) or placed into the proper laboratory waste stream, if applicable.

21.2. All laboratory personnel must be aware of the types of chemicals they are using and the appropriate procedures for their disposal, if applicable.

21.3. Each specific laboratory area shall maintain clearly labeled waste containers for small quantity waste collection. These waste containers shall be used for temporary collection of residual sample from aliquotting procedures, contaminated consumables, sample extracts, purged aqueous samples, and other wastes that require disposal as hazardous waste, if applicable.

21.4. To ensure compliance with Federal RCRA regulations, the Hazardous Waste Coordinator collects and disposes of the hazardous waste at each satellite collection point no less than monthly, if applicable.

21.5. Waste management procedures shall adhere to the current revision of SOP-T005, "Disposal of Laboratory Samples and Waste."

22. REFERENCES

22.1. US EPA, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, January 1997, Method TO-14A, "Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using Specially Prepared Canisters With Subsequent Analysis By Gas Chromatography".

22.2. US EPA, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, January 1997, Method TO-15, "The Determination of Volatile Organic Compounds (VOCs) in Air Collected in Summa® Canisters and Analyzed by Gas Chromatography/Mass Spectrometry".

23. TABLES, DIAGRAMS, FLOWCHARTS AND VALIDATION DATA

23.1. Appendix 1: Ions for Qualitative Identification of Selected Target Compounds.

23.2. Appendix 2: Standard nominal reporting Detection Limits for TO-15.

23.3. Appendix 3: Summa Canister Certification - Quality Control Modifications

24. MODIFICATIONS

24.1. The following modifications from EPA Method TO-14A January 1999 Revision are noted.

Calscience SOP M380 Section	Reference Document EPA Method TO-14A Section	Summary of Modification
10.2.	8.2	Calibration standard concentrations are modified.
11.	7.1, 9, 11.2, and 12.5.1	Sampling system and procedure are excluded.
	10.4.1, 11.1, and 12.5.1	Canister receipt, pressurizing, and cleaning procedures are excluded. These procedures are listed in Calscience SOP-T016.
12.	12.2	Method relative accuracy and linearity criteria are excluded.

24.2. The following modifications from EPA Method TO-14A January 1999 Revision are noted.

Calscience SOP M380 Section	Reference Document EPA Method TO-15 Section	Summary of Modification
10.2.	9.2	Standard preparation procedures are modified.
11.	7.1, 8, 8.4.1	Sampling system and procedure are excluded. Canister receipt, pressurizing, and cleaning procedures are excluded. These procedures are listed in Calscience SOP-T016.
12.1.2.	10.4.4	Tuning criteria are modified.
12.5.1.3.	10.7.5	Blank acceptance criteria are modified.
12.	11.4	Audit accuracy criteria are excluded.

25. REVISION HISTORY

Revision	Description	Author(s)	Effective Date
6.5	Section 1: Specify the use of Tedlar bag is a modified procedure. Section 3: Revise MDL and RL for some analytes, and add reference to MDL determination procedure. Section 4: Specify the use of Tedlar bag is a modified procedure. Section 5: Clarify method summary and specify the use of Tedlar bag is a modified procedure. Section 6: Add LOD/LOQ definitions. Section 9: Update the list of equipment and supplies. Section 10: Revise standard preparation procedure. Section 11: Add reference to sample collection. Sections 12 and 13: Update calibration and quality control criteria. Section 14: Add references to MiniCan canister and manual integration procedure. Section 15: Clarify formulas. Section 18: Modify the data acceptance criteria for MB, LCS, and LCSD. Section 24: List the modifications from EPA Methods TO-14A and TO-15. Section 25: Add a new section for revision history.	E. Winger / K. Chang	08/24/12
12.6 /18.4 App. 3	Remove Surrogate Chart Added Summa Canister QC Modifications	L. Lem	10/14/13
6.7	Section 12: Added information regarding tune criteria	L. Scharpenberg	02/10/14

APPENDIX 1

Table I : Ions for Qualitative Identification of Selected Target Compounds

Compound Name	Qlon E	2nd	3rd	4th
Dichlorodifluoromethane	85	87		
Propene	41	39	42	
1,1-Difluoroethane	51	65		
Chloromethane	50	52		
1,2-Dichloro-1,1,2,2-tetrafluoroethane	101	151	103	153
Vinyl Chloride	62	64		
1,3-Butadiene	54	39	53	50
Bromomethane	94	96		
Chloroethane	64	66		
Ethanol	45	46	43	
Trichlorofluoromethane	101	103		
Acetone	58	43		
Isopropanol	45	43	41	59
1,1-Dichloroethene	61	96	98	
1,1,2-Trichloro-1,2,2-Trifluorethane	101	151	153	
Tert-Butyl alcohol (TBA)	59	57	41	
Carbon Disulfide	76	78		
Acrylonitrile	53	52	51	
Methylene Chloride	84	86		
t-1,2-Dichloroethene	96	98		
Methyl-tert-Butyl Ether	73	57		
1,1-Dichloroethane	63	65	83	
Vinyl Acetate	86	43		
Diisopropyl ether (DIPE)	45	87		
Ethyl t-butyl ether (ETBE)	59	87		
c-1,2-Dichloroethene	96	98		
Hexane	86	57	43	41
Ethyl Acetate	88	43	41	59
2-Butanone	43	72		
Bromochloromethane	130	128		
Tetrahydrofuran	42	41	71	72
Chloroform	83	85		
1,1,1-Trichloroethane	97	61	63	
Carbon Tetrachloride	117	119		
Cyclohexane	56	84	69	41
1,4-Difluorobenzene	114	88		
Benzene	78	51		
1,2-Dichloroethane	62	98	64	49

APPENDIX 1

Table I : Ions for Qualitative Identification of Selected Target Compounds

Compound Name	Qlon E	2nd	3rd	4th
Tert-Amyl methyl ether	73	87	55	
Trichloroethene	95	130	132	
1,4-Dioxane	88	58	43	57
Heptane	100	43	71	57
1,2-Dichloropropane	63	112		
Dibromomethane	93	95	174	
Bromodichloromethane	83	85		
c-1,3-Dichloropropene	75	77	110	
Toluene	91	92		
4-Methyl-2-Pentanone	58	85		
Chlorobenzene-d5	117	82		
t-1,3-Dichloropropene	75	77	110	
1,1,2-Trichloroethane	83	97	85	
Tetrachloroethene	166	164	131	
2-Hexanone	58	43		
Dibromochloromethane	129	127		
1,2-Dibromoethane	107	109		
Chlorobenzene	112	114		
Ethylbenzene	91	106		
p/m-Xylene	91	106		
o-Xylene	91	106		
4-Ethyltoluene	105	120	91	77
Styrene	104	78		
Bromoform	173	175		
1,4-Bromofluorobenzene	95	174		
1,1,2,2-Tetrachloroethane	83	85		
1,3,5-Trimethylbenzene	105	120		
1,2,4-Trimethylbenzene	105	120		
Benzyl Chloride	91	126	65	
1,3-Dichlorobenzene	146	111	148	
1,4-Dichlorobenzene	146	148	111	
1,2-Dichlorobenzene	146	111	148	
1,2,4-Trichlorobenzene	180	182	145	
Hexachloro-1,3-Butadiene	225	223	227	
Naphthalene	128	127		

APPENDIX 2

Standard Analyte, Nominal Reporting Detection Limits (ppbv)

Analyte	CAS Number	RL (PPBV)
Acetone	67-64-1	2.0
Benzene	71-43-2	0.50
Benzyl Chloride	100-44-7	1.5
Bromodichloromethane	75-27-4	0.50
Bromoform	75-25-2	0.50
Bromomethane	74-83-9	0.50
2-Butanone	78-93-3	1.5
Carbon Disulfide	75-15-0	2.0
Carbon Tetrachloride	56-23-5	0.50
Chlorobenzene	108-90-7	0.50
Chloroethane	75-00-3	0.50
Chloroform	67-66-3	0.50
Chloromethane	74-87-3	0.50
Dibromochloromethane	124-48-1	0.50
Dichlorodifluoromethane	75-71-8	0.50
1,1-Dichloroethane	75-34-3	0.50
1,1-Dichloroethene	75-35-4	0.50
1,2-Dibromoethane	106-93-4	0.50
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2	2.0
1,2-DichloroBenzene	95-50-1	0.50
1,2-Dichloroethane	107-06-2	0.50
1,2-Dichloropropane	78-87-5	0.50
1,3-DichloroBenzene	541-73-1	0.50
1,4-DichloroBenzene	106-46-7	0.50
c-1,3-Dichloropropene	10061-01-5	0.50
c-1,2-Dichloroethene	156-59-2	0.50
t-1,2-Dichloroethene	156-60-5	0.50
t-1,3-Dichloropropene	10061-02-6	1.0
Ethylbenzene	100-41-4	0.50
4-Ethyltoluene	622-96-8	0.50
Hexachloro-1,3-Butadiene	87-68-3	1.5
2-Hexanone	591-78-6	1.5
Methyl-t-Butyl Ether (MTBE)	1634-04-4	2.0
Methylene Chloride	75-09-2	5.0
4-Methyl-2-Pentanone	108-10-1	1.5
Naphthalene	91-20-3	10
o-Xylene	95-47-6	0.50
P/m-Xylene	179601-23-1	2.0
Styrene	100-42-5	1.5
Tetrachloroethene	127-18-4	0.50
Toluene	108-88-3	0.50
Trichloroethene	79-01-6	0.50
Trichlorofluoromethane	75-69-4	1.0

APPENDIX 2

Standard Analyte, Nominal Reporting Detection Limits (ppbv)

Analyte	CAS Number	RL (PPBV)
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	1.5
1,1,1-Trichloroethane	71-55-6	0.50
1,1,2-Trichloroethane	79-00-5	0.50
1,3,5-TrimethylBenzene	108-67-8	0.50
1,1,2,2-Tetrachloroethane	79-34-5	1.0
1,2,4-TrimethylBenzene	95-63-6	1.5
1,2,4-TrichloroBenzene	120-82-1	2.0
Vinyl Acetate	108-05-4	2.0
Vinyl Chloride	75-01-4	0.50
Tetrachloroethene	127-18-4	0.50
Toluene	108-88-3	0.50
Trichloroethene	79-01-6	0.50
Trichlorofluoromethane	75-69-4	1.0
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	1.5
1,1,1-Trichloroethane	71-55-6	0.50
1,1,2-Trichloroethane	79-00-5	0.50
1,3,5-TrimethylBenzene	108-67-8	0.50
1,1,2,2-Tetrachloroethane	79-34-5	1.0
1,2,4-TrimethylBenzene	95-63-6	1.5

APPENDIX 3

1. Summa Canister Certification - Quality Control Modifications

   1.1 Primary Calibration Standards - Two cylinders

      1.1.1. Initial Calibration standard containing each target analyte at a nominal concentration of 1000ppbv.

      1.1.2. Working Initial Calibration Standards

      1.1.3. One working calibration mix at 8ppbv is prepared by using the Environics gas mixer.

   1.2 Initial and Continuing Calibration:

      1.2.1 An initial six-point calibration is obtained by injecting 0.4, 1, 2, 4, 6 and 8 ppbv standards into the GCMS.

      1.2.2 Each calibration concentration is achieved by varying the volume of the working standard (50mL, 125mL, 250mL, 500mL, 750mL and 1000mL respectively).

   1.3 Second Source Verification Standard (ICV/LCS)-2 cylinders

      1.3.1 One ICV/LCS working mix at 8ppbv is prepared by using the Environics gas mixer.

      1.3.2 The ICV/LCS is obtained by injecting 4ppbv (500mL) of the ICV/LCS/LCSD working standard into the GC/MS.

   1.4 Laboratory Control Sample and Duplicate (LCS/LCSD)

      1.4.1 The LCS is a known gaseous matrix containing a known concentration of specific target analytes (4ppbv).

      1.4.2 The LCS/LCSD is obtained by injecting 4ppbv (500mL) of the ICV/LCS/LCSD working standard.

Title : **EPA METHOD TO-15, VOLATILE ORGANIC COMPOUNDS BY GAS CHROMATOGRAPHY / MASS SPECTROMETRY (GC/MS) IN AIR USING SUMMA® CANISTERS AND SELECTIVE ION MONITORING (SIM)**

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PROPRIETARY INFORMATION STATEMENT

Revision 1.0 changes are noted in bold italicized typeface and preceded by a "►" marker

APPROVED FOR RELEASE BY: _____ 03/11/13
MANAGEMENT **DATE**

_____ 03-11-13
QA DEPARTMENT **DATE**

1. METHOD IDENTIFICATION

1.1. EPA Method TO-15 Volatile Organic Compounds by Gas Chromatography / Mass Spectrometry in Air using Summa® canisters and Selective Ion Monitoring (SIM).

2. APPLICABLE MATRICES

2.1. This method is applicable for indoor and ambient air samples collected in 6-liter summa canisters. There can be exceptions, but be advised of the following:

2.1.1. The use of Tedlar bags for TO-15 SIM analysis is not recommended due to the low quantitation limits required and are considered to be a deviation to the TO-15 method.

2.1.2. The use of smaller summa canisters, i.e. 1-liter, may not yield sufficient volume to achieve the low detection limits reported by this method.

2.1.3. The use of the TO-15 SIM method for soil gas or sub-slab air samples may yield elevated detection limits due to the nature of the samples collected.

3. ►DETECTION LIMITS

3.1. The estimated quantitation limits (EQLs) generated for the compounds determined using the SIM method are approximately 0.025 ppbv, but may be higher for some analytes. The EQLs will be proportionally higher for samples that require dilution.

3.2. ***Please refer to Appendix 2 for standard TO-15 SIM analyte and reporting limits.***

4. SCOPE AND APPLICATION

4.1. The TO-15 SIM method is used to determine the concentration of a select number of volatile organic compounds (VOCs) having a vapor pressure greater than 10^{-1} torr at 25°C at standard pressure. The low detection and quantitation limit for these analytes is determined by operating the instrument in selective ion monitoring (SIM) mode. Samples are collected in 6 liter Summa® canisters.

4.2. The following compounds can be routinely determined by this method:

Benzene	1,1-Dichloroethene	Toluene
Bromodichloromethane	c-1,2-Dichloroethene	Tetrachloroethene
Carbon tetrachloride	t-1,2-Dichloroethene	Trichloroethene
Chlorobenzene	Ethylbenzene	Trichlorofluoromethane
Chloroethane	4-Ethyltoluene	1,1,1-Trichloroethane
Chloromethane	Hexachloro-1,3-butadiene	1,1,2-Trichloroethane
Chloroform	Methyl-t-Butyl Ether (MTBE)	1,3,5-TrimethylBenzene
Dibromochloromethane	Methylene chloride	1,1,2,2-Tetrachlorethane
Dichlorodifluoromethane	o-Xylene	1,2,4-TrimethylBenzene
1,1-Dichloroethane	p/m-Xylene	Vinyl Chloride
1,2-Dichloroethane	1,1,2-Trichloro-1,2,2-Trifluoroethane	1,1-Difluoroethane*

4.3. Additional analytes that may be analyzed for using TO-15 SIM (by request only):

Acetone	Hexane	Isopropanol*
Benzyl Chloride	Cyclohexane	Naphthalene
Bromoform	Heptane	1,4-Dioxane
Bromomethane	1.2.4-trichlorobenzene	2-butanone
Carbon Disulfide	1.2-dibromoethane	2-hexanone
Ethanol	Dichlorotetrafluoroethane	4-methyl-2-pentanone
Styrene	1.2-dichlorobenzene	1,3-Butadiene
c-1,3-dichloropropene	1.3-dichlorobenzene	1.2-dichloropropane
t-1,3-dichloropropene	1.4-dichlorobenzene`	

* leak check compound

4.4. This method is restricted to use by or under the supervision of analysts and supervisors who are experienced in the use of GC/MS and skilled in the interpretation of mass spectra both in scan and SIM mode.

5. METHOD SUMMARY

5.1. EPA Method TO-15 SIM describes chromatographic procedures that will allow for the separation of volatile organic compounds and their qualitative and quantitative analysis by mass spectrometry.

5.2. A known volume of sample is directed from the Summa® canister to a multi-module (empty trap, tenex, cryofocuser) concentrator. The sample is first dehydrated by passing through a cold, empty trap, and then cryogenically concentrated on Tenax. Post concentration, the VOC's are thermally desorbed onto a gas chromatographic column for separation prior to detection.

5.3. Detection is achieved using a mass selective detector and quantitation is performed using the selective ion monitoring mode. With the selected ion monitoring technique, the mass spectrometer is not scanned over all masses; instead, the instrument jumps from one selected mass to another allowing the MS to spend more time at a given mass, thus improving the signal-to-noise ratio at a mass and therefore the sensitivity at that mass.

6. ►DEFINITIONS

6.1. Abundant: An ion that is easy to detect at low concentrations

6.2. Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents.

6.3. Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

6.4. Analytical Batch: Samples, which are analyzed together as a group with the same process and personnel, using the same reagents and can exceed 20 samples.

6.5. Calibration: To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device. The levels of the calibration standards should bracket the range of expected sample measurements.

6.6. Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

6.7. Dwell: The amount of time (in msec) spent monitoring each m/z value during SIM. A dwell time can be specified for each group.

6.8. Group: The set of m/z values monitored during a given SIM cycle. The maximum group size is 30 ions. Fifty groups of up to 30 ions can be created.

6.9. Holding Times: The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.10. Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

6.11. Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory precision and bias and to assess the performance of the measurement system.

6.12. ***Limit of Detection (LOD): A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility.***

6.13. ***Limit of Quantitation (LOQ): The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence.***

6.14. Method Blank: A sample of a matrix similar to the batch of associated samples that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

6.15. Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

6.16. Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

6.17. Raw Data: Any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. If exact copies of raw data have been prepared (e.g., tapes

which have been transcribed verbatim, data and verified accurate by signature), the exact copy or exact transcript may be submitted.

6.18. Selective ion Monitoring (SIM): A sensitivity enhancement technique, where the mass spectrometer is programmed to scan for only those ions that are pertinent to the compounds of interest (2-3 mass ions scanned per compound) while ignoring non-essential ions.

6.19. Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for QC purposes.

7. INTERFERENCES

7.1. Contamination by carryover can occur whenever high and low concentration level samples are analyzed sequentially. Suspected high level samples should be diluted and then analyzed at the end of the sequence to prevent carryover contamination. The analysis of blanks after high concentration samples is encouraged.

7.2. Interference can also occur when "dirty" samples leave residue in the column. The column can be "baked" after such samples.

7.3. The following provides information regarding possible interferences and target analyte anomalies during analytic processing:

7.3.1. Very volatile compounds such as Chloromethane and Vinyl Chloride can display peak broadening and co-elution with other species if the compounds are not delivered to the column in a small volume or carrier gas. Refocusing of the sample after collection on the primary trap, either on a separate focusing trap or at the head of the column, mitigates this problem.

7.3.2. Interferences in canister samples may result from improper use or from contamination of: 1) the canisters themselves due to poor manufacturing, 2) the canister cleaning apparatus, or 3) the sampling or analytical system. Attention to the following details will help to minimize the possibility of contamination of canisters.

7.3.2.1. New canisters are cleaned per SOP T-016, filled with high-purity Nitrogen and then analyzed to determine cleanliness. Pending and post analysis, canisters should be stored in a contaminant-free location.

7.3.2.2. Impurities in the calibration dilution gas and carrier gas, organic compounds out-gassing from system components ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system itself must be demonstrated free of contamination by the periodic analysis of humidified zero air blanks.

7.3.3. Best efforts must be taken to maintain the analytical areas free of all contaminants that include target analytes that are common solvents or reagents in other areas of the laboratory. This can be minimized by restricting entry of these solvents or solvent-contaminated items (e.g., laboratory coats) into the VOC laboratory and proper management / maintenance of laboratory ventilation.

7.3.4. Other major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap. The use of non-Polytetrafluoroethylene (PTFE) thread sealants, plastic tubing, or flow controllers with rubber BUNA-N components should be avoided since such materials out-gas organic compounds which will be concentrated in the trap during the purge operation. Analyses of blanks provide information about the presence of contaminants. When potential interfering peaks are noted in blanks, the analyst should locate and remove the source of contamination before proceeding with calibration and analysis.

7.3.5. Special precautions must be taken to analyze for methylene chloride. The analytical and sample storage area should be isolated from all atmospheric sources of methylene chloride. Otherwise, random background levels will result. Since methylene chloride will permeate through PTFE tubing, all gas chromatography carrier gas lines and purge gas plumbing should be constructed from chromatographic grade stainless steel or copper tubing. Laboratory clothing worn by the analyst should be clean since clothing previously exposed to methylene chloride fumes during SVOC extraction procedures may contribute to sample contamination.

7.4. Summa Canister Cleaning is referenced under SOP T-016.

8. SAFETY

8.1. Exposure to hazardous chemicals should be minimized through the use of proper protective equipment and safe laboratory practices as referenced in the current version of Calscience's Health, Safety, and Respiratory Protection Manual. In general, safety glasses and laboratory coats should be worn in the air laboratory. Protective gloves shall be worn when handling liquid or solid chemicals.

8.2. The following compounds covered by this method have been tentatively classified as known or suspected human carcinogens: benzene, methylene chloride, chloroform, Bromoform, Bromodichloromethane, Chlorodibromomethane, and Vinyl Chloride. Primary standards of these toxic compounds must be prepared in a hood.

8.3. Material Safety Data Sheets (MSDSs) are available for each laboratory standard and reagent chemical. Employees should review and be familiar with the hazards and precautions outlined in the MSDS for all chemicals to be used prior to handling.

9. ►EQUIPMENT AND SUPPLIES

9.1. Gas Chromatograph:

9.1.1. Agilent 6890 Gas Chromatograph configured with a PC based data system - Chemstation or equivalent.

9.2. ***Instrument Software***

9.2.1. ***Use of a PC based computer is required.***

9.2.2. ***Agilent MSD ChemStation Version E.02.00.493, Agilent MSD ChemStation Version E.02.01.1177, or equivalent equipped with NIST mass spectral library.***

9.3. ***Instrument Maintenance and Troubleshooting***

9.3.1. ***Refer to the current revision of SOP-T066 and instrument manual(s) for maintenance and troubleshooting.***

9.4. Entech 7016 Autosampler or equivalent

9.5. Entech 7100 Cryogenic Concentrator or equivalent

9.6. Mass Spectrometer:

9.6.1. Agilent 5973 Mass Selective Detector (MSD) or equivalent capable of operating in Selective Ion Monitoring (SIM) mode.

9.6.2. The MSD must be capable of producing a mass spectrum for BFB that meets all of the criteria in Section 12.1 below, when 100ppbv of BFB is injected.

9.7. Chromatographic Column:

9.7.1. J&W DB-1 or Restek RTX-1, 60M, 0.32mm ID, 1.0µ film or equivalent.

9.8. 6-liter Summa® or Silonite Polished Canisters, or equivalent – certified clean to the MDL or RL as needed, for samples, QC and Standards.

9.9. Environics Series 2000 Computerized Multi-Component Gas Mixer.

9.10. 2-stage regulators capable of handling pressures up to 4000psi and 200psi

9.11. Stainless steel or inert teflon tubing with Swagelock fittings, or equivalent

9.12. Gas Tight Syringes:

9.12.1. Hamilton 702N gas tight Leurlock type w/ on-off valves or equivalent, sizes 1mL, 2.5mL, 5mL, 25mL, 50mL, and 100mL.

10. ►REAGENTS AND STANDARDS

10.1. REAGENTS

10.1.1. Zero Air

10.1.2. Reagent grade water for humidifying Summa canisters

10.2. STANDARDS

10.2.1. A tuning standard containing 100ppbv of 4-bromofluorobenzene (BFB) made up in a tedlar bag. The tuning standard also contains the internal and surrogate standards in the same amount as samples, QC and standards.

10.2.1.1. 64mL of the tuning standard is injected onto the instrument

10.2.2. Internal and Surrogate standards – 1 canister:

10.2.2.1. Internal Standards: Bromochloromethane, Chlorobenzene-d_5 and 1,4-Difluorobenzene each at a nominal concentration of 2.0ppbv.

10.2.2.2. Surrogates: 1,4-Bromoflurobenzene (also used as the tuning standard), 1,2-Dichloroethane-d_4 and Toluene-d_8 each at a nominal concentration of 2.0ppbv.

10.2.2.2.1. 100mL of Internal/Surrogate standard is analyzed with every sample, QC sample, and method blank. This is equivalent to a 0.5ppbv standard.

10.2.3. Primary Calibration Standards in 2 canisters containing each target analyte at a nominal concentration of 1000ppbv.

10.2.4. Intermediate Calibration Standard – 25ppbv

10.2.4.1. The 25ppbv intermediate calibration mix (Ethanol at 400ppbv) is made by blending 20ml/min of each canister with 760ml/min of zero air in an evacuated Summa® canister.

10.2.4.2. Press RECALL and 04 followed by START or UPDATE on the Environics Series 2000 Computerized Multi-Component Gas Mixer. The Primary standard canisters are hooked up to the gas mixer and are ready for use. Input the appropriate volumes of the standards and the zero air to make up the working standards.

10.2.5. Working Initial and Continuing Calibration Standards

10.2.5.1. ***Two working calibration standards are made by direct dilution from the 25ppbv intermediate calibration standard – 0.25ppbv and 1.25ppbv. The other four calibration standards are made by dilution of, or injecting lesser volumes of, the two working calibration standards.***

10.2.5.1.1. The 0.25ppbv working calibration standard is made by blending 10mL of the 25ppbv intermediate standard with 990ml/min of zero air in an evacuated 6 liter Summa® canister.

10.2.5.1.2. ***The 1.25ppbv working calibration standard is made by blending 50mL of the 25ppbv intermediate standard with 960ml/min of zero air in an evacuated 6 liter Summa® canister.***

10.2.5.2. ***The 0.01ppbv calibration standard is made by injecting 16mL of the 0.25ppbv working calibration standard onto the instrument.***

10.2.5.3. ***The 0.020ppbv calibration standard is made by injecting 32mL of the 0.25ppbv working calibration standard onto the instrument.***

10.2.5.4. The 0.05ppbv calibration standard is made by injecting 80mL of the 0.25ppbv working calibration standard onto the instrument.

10.2.5.5. The 0.10ppbv calibration standard is made by injecting 160mL of the 0.25ppbv working calibration standard onto the instrument.

10.2.5.6. The 0.25ppbv calibration standard is made by injecting 100mL of the 1.0ppbv working calibration standard onto the instrument.

10.2.5.6.1. Alternately, 400mL of the 0.25ppbv working calibration standard may be injected used.

10.2.5.6.2. This standard is also used for the daily CCV.

10.2.5.7. The 0.50ppbv calibration standard is made by injecting 200mL of the 1.0ppbv working calibration standard onto the instrument.

10.2.5.8. ***The 1.25ppbv calibration standard is made by injecting 400mL of the 1.25ppbv working calibration standard onto the instrument.***

10.2.5.9. ***The 2.5ppbv calibration standard is made by injecting 40mL of the 25ppbv working calibration standard onto the instrument.***

10.2.5.10. ***The 5ppbv calibration standard is made by injecting 80mL of the 25ppbv working calibration standard onto the instrument.***

10.2.6. Second Source Verification Standard (ICV/LCS) - 2 canisters:

10.2.6.1. The second source standard is made from two different canisters (a separate source from the ICAL standard) by blending 20ml/min of each second source canister with 760ml/min of zero air in a Summa® canister to create a 25ppbv standard.

10.2.6.1.1. Press RECALL 06 followed by START or UPDATE on the Environics Series 2000 Computerized Multi-Component Gas Mixer. The secondary source standard canisters are hooked up to the gas mixer and are ready for use. Input the appropriate volume of the standard and the zero air to make up the working ICV/LCS standard.

10.2.6.1.2. Attach and fill the evacuated LCS 6 liter Summa® Canister.

10.2.6.2. ***The 25ppbv standard is then used to create a 1.25ppbv second source ICV/LCS standard by blending 50ml/min of the 25ppbv standard with 950ml/min of zero air.***

10.2.6.2.1. ***160mL of the 1.25ppbv standard is injected onto the instrument; final nominal concentration of 0.5ppbv.***

11. SAMPLE COLLECTION, PRESERVATION, CONTAINERS AND HOLDING TIMES

11.1. Air samples collected in Summa® canisters must be analyzed within 30 days of collection. Preservation is not required (store at ambient temperature).

11.1.1. Regulatory agencies may require shorter hold times than 30 days. It is the responsibility of the Client to relay differing requirements as appropriate to Calscience. From there it is the responsibility of the Calscience Project Manager to relay this information to the Air group.

11.2. Air samples collected in Tedlar™ bags must be analyzed with 3 days of collection. Preservation is not required (store at ambient temperature).

11.2.1. When analyzed in Tedlar™ bags, the report results will include a comment noting a deviation to the TO-15 method as the EPA TO-15 method makes no reference to Tedlar™ bags as a sampling medium.

12. ►QUALITY CONTROL

12.1. Hardware Tuning

12.1.1. An acceptable tune demonstrates satisfactory hardware performance. A tune meeting the acceptance criteria is required and MUST be recorded prior to any ICAL, CCV, QC or sample analyses.

12.1.2. Prior to running the calibration standard(s) or CCVs, the GC/MS BFB tuning standard must be analyzed and meet the following acceptance criteria:

Mass	Ion Abundance Criteria
50	15 - 40% of mass 95
75	30 - 60% of mass 95
95	Base peak, 100% relative abundance[Note 1]
96	5 - 9% of mass 95
173	< 2% of mass 174
174	> 50% to 120% of mass 95
175	5 - 9% of mass 174
176	Greater 95% but less than 101% of mass 174
177	5 - 9% of mass 176

Note 1: All ion abundances must be normalized to mass 95, the nominal base peak, even though the ion abundance of mass 174 may be up to 120% of mass 95.

12.1.3. These criteria must be demonstrated initially and, at a minimum, every 24 hours thereafter, prior to any other analyses.

12.1.4. If a tune does not meet the acceptance criteria, correct the problem and re-tune the system.

12.1.5. Whenever invasive maintenance of the GC/MS hardware is performed, the system must be re-tuned.

12.2. Initial Calibration

12.2.1. ***A minimum of a five-point, initial calibration must be established prior to the processing of samples.***

12.2.2. The initial calibration is deemed valid if:

12.2.2.1. The %RSD for the RF for each target analyte is <30% with, at most, two exceptions up to a limit of 40%.

12.2.2.2. The %RSD for the RRT for each target analyte at each concentration level is within 0.06 RRT units of the mean RRT of the target analyte.

12.2.2.3. The internal standard area response Y at each calibration level must be within 40% of the mean Y over the initial calibration range.

12.2.2.4. The retention time shift for each of the internal standards at each calibration level must be within 20 seconds of the mean retention time over the initial calibration range for each internal standard.

12.3. Initial Calibration Verification (ICV)

12.3.1. Immediately following establishment of a valid initial calibration, an ICV standard must be analyzed. The ICV is the second source standard used for the LCS/LCSD.

12.3.1.1. ***The ICV is deemed valid if the %D for each target analyte is ±30%, with at most two exceptions up to a limit of 40%.***

12.3.1.2. If these criteria are not met, the ICV/LCS is deemed unacceptable for sample analysis to resume. Reanalyze the ICV/LCS.

12.3.1.2.1. If the ICV/LCS criteria remain unacceptable, effect corrective action and re-tune/recalibrate. If acceptable, proceed with sample analysis.

12.3.1.3. The internal standard area responses and retention times in the ICV must be evaluated after data acquisition. If the retention time for any internal standard changes by more than 20 seconds from the mean retention time in the initial calibration, the chromatographic system must be inspected for malfunctions and corrective action must be effected.

12.3.1.4. If the area response for any internal standard changes by +/- 40% from the mean area response in the initial calibration, the system must be inspected for malfunctions and corrective action effected. Following corrective action, reanalyze the ICV. If still out, recalibrate.

12.4. Continuing Calibration Verification (CCV)

12.4.1. Following establishment of a valid initial calibration and every 24 hours thereafter, a CCV standard must be analyzed following the tune standard.

12.4.1.1. The CCV is deemed valid if the %D for each target analyte is ±30%.

12.4.1.2. If these criteria are not met, the CCV is deemed unacceptable for sample analysis to resume. Reanalyze the CCV. If the CCV

criteria remain unacceptable, effect corrective action and re-tune/recalibrate.

12.4.1.3. The internal standard area responses and retention times in the CCV must be evaluated after or during data acquisition. If the retention time for any internal standard changes by more than 20 seconds from the last CCV (24 hours), the chromatographic system must be inspected for malfunctions and corrective action must be effected.

12.4.1.4. If the area response for any internal standard changes by more than +/- 40% (Range: 60% to 140%) from the mean area response of the initial calibration, the system must be inspected for malfunctions and corrective action effected. Following corrective action, re-analysis of samples analyzed while the system was malfunctioning is required.

12.4.1.5. If these criteria are not met then all samples analyzed since the last acceptable CCV should be invalidated, corrective action effected, and the affected samples re-analyzed. If a failed CCV is the first of the day, corrective action must be effected prior to analyzing any samples.

12.5. Event Based Quality Control (MB, BB and LCS/LCSD)

12.5.1. Method Blank: (MB):

12.5.1.1. The Method Blank is an instrument blank analyzed directly from the autosampler. In the processing of the MB, the surrogates and internal standards identical to those for actual samples are used.

12.5.1.2. Additionally, a summa blank is also analyzed to monitor the autosampler process.

12.5.1.2.1. The summa blank is pressurized with humidified Zero Air and is processed concurrently with the associated field samples.

12.5.1.2.2. One method blank is required every 20 samples.

12.5.1.3. Ideally, the concentration of target analytes in a MB should be less than the respective reporting limits (RLs). (Less than ½ the RL for DOD work) If the concentration of any target analyte exceeds its RL, the source of contamination must be investigated and, if possible, eliminated. The acceptance criteria for MBs is as follows:

12.5.1.3.1. If a target analyte is found in the MB but not in the associated samples, report the sample and MB data without qualification.

12.5.1.3.2. If a target analyte is found in the MB and in the associated samples, evaluate the analyte in question to determine the effect on the analysis of samples. Determine and eliminate the source of contamination. Professional judgment should be exercised to

determine if the data should be qualified or rejected and the samples re-analyzed.

12.5.1.4. Internal Standard Retention Times (RT) must be +/- 0.33 minutes.

12.5.1.5. The area response for each internal standard in the method blank must be within ±40% (Range: 60% to 140%) of the mean area response of the internal standards in the most recent initial calibration.

12.5.2. Tedlar Bag Blank (BB):

12.5.2.1. Although unlikely, samples received in Summa canisters for SIM analysis may require dilution to account for high levels of hydrocarbons, non-target or target analytes. When the dilution cannot be performed directly from the summa canister, the dilutions are performed in tedlar bags.

12.5.2.2. To monitor potential contamination from the tedlar bags used for dilution, a Bag Blank (BB) is analyzed along with the standard method blank.

12.5.2.3. The acceptance and reporting criteria for the bag blank are as follows.

12.5.2.3.1. If no target analytes are detected, batch all sample analyses with the MB and file the BB raw data with the QC paperwork.

12.5.2.3.2. If target analytes are detected in the BB but not in the Tedlar bag dilution samples, batch all sample analyses with the MB and file the BB raw data with the QC paperwork.

12.5.2.3.3. If target analytes are detected in the BB and in the corresponding Tedlar bag sample dilutions, batch the dilutions with the BB and file the BB raw data with the QC paperwork.

12.5.2.3.3.1. Create separate batches for the MB and the BB. Summa analyses are batched with the MB. Tedlar bag dilutions are batched with the BB. Flag results as needed.

12.5.2.4. Internal Standard Retention Times (RT) must be +/- 0.33 mins.

12.5.2.5. The area response for each internal standard in the method blank must be within ±40% (Range: 60% to 140%) of the mean area response of the internal standards in the most recent initial calibration.

12.5.3. Lab Control Sample (LCS/LCSD):

12.5.3.1. ***The LCS is a known gaseous matrix containing a known concentration of specific target analytes (0.5ppbv). The purpose of the LCS is to demonstrate that the entire analytical process and systems are in control. The LCSD is a duplicate of the LCS.***

12.5.3.2. The LCS/LCSD is processed concurrently with the associated samples. In the processing of the LCS/LCSD, reagents and procedures identical to those for actual samples are used. The LCS/LCSD should be run after the CCV and is required for every batch of 20 samples or portion thereof, whichever is more frequent.

12.5.3.3. In addition to assessing the accuracy of the analytical measurement, the LCSD, in combination with the LCS, is used to assess the precision of the analytical process. The measurement is expressed as relative percent difference (RPD).

12.5.3.4. The acceptance criteria for LCS/LCSD compounds vary depending upon historical data. The upper and lower acceptance limits for each LCS/LCSD compound are based upon the historical average recovery ±3S.

12.5.3.5. All LCS/LCSD compounds must be within the current historical control limits as noted in the table in Appendix 2. If one or more LCS/LCSD compounds are not acceptable, the problem must be identified and corrected.

12.5.3.6. Internal Standard Retention Times (RT) must be +/- 0.33 minutes.

12.5.3.7. Internal Standard Retention Areas must be +/- 40% (Range: 60% to 140%) of initial calibration

12.6. Sample Based Quality Control (Surrogates)

12.6.1. The acceptance criteria for surrogate spike compound recoveries vary depending upon historical data. The upper and lower acceptance limits for each surrogate spike compound is based upon the historical average recovery ± 3S.

12.6.2. The % recovery criteria for standard analyte reporting is currently as follows:

Analyte	% Recovery
1,4-Bromofluorobenzene	45-153
1,2-Dichloroethane-d4	37-163
Toluene-d8	73-121

12.6.2.1. If the surrogate compound recoveries are acceptable, report the surrogates and sample data without qualification.

12.6.2.2. If one or more surrogate recoveries are not acceptable, evaluation is not necessarily straightforward. The sample itself may produce

effects due to such factors as interferences and high analyte concentration or a problem may have occurred during extraction.

12.6.2.3. The data alone cannot be used to evaluate the precision and accuracy of individual sample analyses. However, when exercising professional judgment, this data should be used in conjunction with other available QC information.

12.6.2.4. By itself, unacceptable surrogate recoveries do not invalidate sample data. The following must be accomplished if surrogate recoveries are not acceptable.

12.6.2.4.1. Check the internal standard and surrogate spiking mixtures for degradation and contamination.

12.6.2.4.2. If the nonconformance is due to poor instrument performance or if the above actions fail to reveal the cause of the unacceptable surrogate(s) recovery, the sample should be re-analyzed.

12.6.2.4.3. If incorrect procedures or degraded/contaminated spiking mixtures are determined to have not caused the unacceptable surrogate recoveries, the affected sample(s) must be re-analyzed or, if insufficient sample remains, reference made to the associated MB surrogate recoveries and the sample data reported with qualification.

12.6.2.4.3.1. If, upon re-analysis, the surrogates remain unacceptable, matrix interference can be cited and reference made to the associated MB surrogate recoveries and the sample data reported with qualification.

12.6.2.4.3.2. If the MB surrogates are unacceptable, all associated sample data must invalidated and all associated samples re-analyzed.

12.6.3. Sample Based Quality Control (Internal Standards)

12.6.3.1. Internal Standard Retention Times (RT) must be +/- 0.33 minutes.

12.6.3.2. Internal Standard Retention Areas must be +/- 40% (Range: 60% to 140%) of initial calibration.

12.7. Method Detection Limit (MDL):

12.7.1. An MDL must be established prior to the analysis of samples, whenever major instrument changes are made, or annually following the procedures outlined in SOP-T006, Determination of Detection Limits.

12.7.2. The formula for calculating the MDL is listed Section 15.6.

12.7.3. MDLs should be verified immediately following the establishment of the MDL at >1x - 4x the MDL value for each analyte. MDL's may then be re-verified on a quarterly or annual basis as required by project or client requirements.

12.8. Demonstration of Capability

12.8.1. Performance of this method is restricted to analysts experienced in the use of the instruments and apparatus required in executing this method and interpretation of mass spectra.

12.8.2. Each analyst must demonstrate the ability to generate acceptable results and quality control prior to the analysis of billable samples.

12.8.2.1. Prior to beginning the analysis, analysts are required to initially demonstrate method competence by generating 4 LCSs that meet the acceptance criteria for the method. Additionally, analysts are required to generate continuing demonstrations of capability on an annual basis to show continued proficiency.

12.9. Additional information regarding internal QC checks is provided in SOP-T020.

13. ►CALIBRATION AND STANDARDIZATION

13.1. Prior to the analysis of samples or QC samples, the GC/MS system must be hardware tuned and an initial calibration established. The acceptance criteria for the tuning parameters are listed in Section 12.1.

13.2. Tuning:

13.2.1. Three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged. Background subtraction is required and must be accomplished using a single scan no more than 20 scans prior to the elution of the BFB. Do not background subtract part of the BFB peak.

13.2.2. Additionally, baseline separation of Benzene and Carbon Tetrachloride is an indication of acceptable chromatographic performance and must be achieved prior to establishment of the calibration. If not, check or replace the column.

13.3. Initial and Continuing Calibration :

13.3.1. ***An initial nine-point calibration is obtained by injecting 0.01, 0.02, 0.050, 0.10, 0.25, 0.50, 1.25, 2.5 and 5ppbv standards into the GCMS.***

13.3.1.1. The ICAL is acceptable if the %RSD for the RF for each target analyte is ≤30% with the exception of two target analytes, to a limit of ≤40%.

13.3.2. Prior to the analysis of any samples or QC samples and after obtaining an acceptable initial calibration, the ICAL must be verified by the analysis of an Initial Calibration Verification standard (ICV/LCS).

13.3.2.1. ***The ICV is deemed valid if the %D for each target analyte is ±30%, with at most two exceptions up to a limit of 40%.***

13.3.3. To verify the continued validity of the ICAL, a continuing calibration verification (CCV) must be analyzed prior to analyzing any QC or samples. This is done daily at the start of each batch, following the tuning standard.

13.3.3.1. The CCV is deemed valid if the %D for each target analyte is 30%.

14. PROCEDURE

14.1. Samples are initially analyzed directly from the canister (1x dilution) without pressurization. In the event that matrix effects or high levels of target or non-target analytes are present, dilutions will be required. The reporting and detection limits will be elevated by the dilution factor.

14.2. Samples should be loaded in the following order:

- Tuning Standard
- Continuing Calibration Verification (CCV)
- Laboratory Control Sample (LCS)
- LCS Duplicate (LCSD)
- Method Blank (MB)
- Samples (up to 20)

14.2.1. Summa® canisters are usually analyzed as received from the field (at vacuum) but some may need to be pressurized prior to analysis. Refer to SOP, T-016 for pressurization procedures.

14.3. Attach to the samples to the autosampler "tree" by using the metal Swage-type connections for Summa® canisters.

14.4. Edit the sequence in the data system. After all correct sample information is entered, save the sequence. After saving the sequence, record pertinent information in the run logbook.

14.5. Initiate the sequence.

14.6. SIM Analysis – Set-up and Theory

14.6.1. Selected Ion Monitoring (SIM) allows the mass spectrometer to detect specific compounds with very high sensitivity. In SIM mode, the instrument is set to gather data at masses of interest, instead of stepping the mass filter over a wide range of masses. Since the mass spectrometer collects data at only the masses of interest, it responds only to those compounds that possess the selected mass fragments. In essence, the instrument is focused on only the compounds of interest. Also, because only a few masses are monitored, much more time may be spent looking at these masses, with the attendant increase in sensitivity.

14.6.2. SIM also allows the collection of more points across a chromatographic peak, thus enhancing the accuracy and precision of quantitative results. To achieve the potential benefits of SIM, careful attention must be paid to the

acquisition parameters. In general, the following items need to be addressed prior to, during and after analysis has been completed:

14.6.2.1. Select appropriate ions to monitor for each target compound.

14.6.2.2. Group signals to be monitored into time programmed SIM groups to minimize the number of ions acquired at any one time.

14.6.2.3. Select a dwell time for each group that yields 15-20 cycles across a peak.

14.6.3. Selecting appropriate ions to monitor:

14.6.3.1. It is common practice to monitor at least two, possibly three ions per surrogate or target analyte. One ion signal is used to quantitate, and the others are used for qualitative information. Since, by definition, internal standards are present in every sample, it is common practice to monitor only one or possibly two ions for the internal standard: the quant ion and possibly one qualifier.

14.6.3.2. Determination of the SIM ions is of utmost importance. For most analytes that are analyzed by the SIM technique, the method has already been established and the ions predetermined. Refer to Appendix 1, Table 1 for the current ions.

14.6.3.2.1. If you are adding new analytes you will need to reference another source for those analytes without predetermined SIM criteria. These references could come from a full list TO-15 scan analysis if available in the lab, or you may need to analyze a scan-mode spectrum of the compounds you plan to analyze by SIM.

14.6.3.3. When examining the spectrum for candidate SIM ions, consider ions that are:

14.6.3.3.1. Unique to the compound (not common in a wide range of compound spectra). If selecting a derivatized compound, do not select ions that represent only the portion of the molecule added by the derivatizing step.

14.6.3.3.2. Higher in mass (usually more specific and separated from interference). Ions of higher mass to charge are usually more unique.

14.6.3.3.3. Abundant. If you chose an ion of very low abundance (albeit very unique), this compound may not be found at low concentrations.

14.6.3.3.4. Characteristic of the compound class (in some cases). For example, if you are looking aromatic hydrocarbons, the molecular ion is typically very

abundant (possibly the base peak). This would be an excellent choice for a quant ion or a qualifier.

14.6.3.4. Once you have chosen the fragments to be monitored, it is important to determine the accurate mass (± 0.1 AMU) for the fragments you will monitor. The fragment labeled m/z 371 may be more accurately measured as 371.2 or 371.3. This deviation from whole numbers is due to the mass defect of certain elements, and the measured mass is called the Mass Centroid.

14.6.3.4.1. For optimum sensitivity and stability, you should monitor the Mass Centroid in your SIM Method to ± 0.1 AMU.

14.6.3.5. There are two ways to determine the Mass Centroid and the validity of these measurements depends on an accurately calibrated mass axis. (Insure the mass axis is accurately calibrated before proceeding.)

14.6.3.5.1. Tabulate a full scan spectrum. Prepare a standard sample of sufficient concentration to obtain scan spectra of the compounds of interest. Inject the standard sample then tabulate the mass spectrum for several data points across the apex of the peak in the resulting data file. Use the m/z value shown in the tabulation (to the nearest 0.1 AMU) for the SIM acquisition mass.

14.6.3.5.1.1. If necessary, take the mathematical average of several scans across the apex to the nearest 0.1 AMU.

14.6.3.5.2. Perform a dynamic SIM calibration. Set up a SIM acquisition for several incremental masses around the ion of interest.

14.6.3.5.2.1. For example, if you are looking for the 76 and 91 ions in toluene, do a SIM acquisition for the 75.9, 76.0, 76.1, 76.2, 90.9, 91.0, 91.1 and 91.2 ions.

14.6.3.5.3. Evaluate the mass spectrum and use the strongest ion for each of these fragments in your SIM Method.

14.6.4. Grouping ions into SIM groups:

14.6.4.1. To gain the benefits of SIM, one must limit the number of ions being monitored at any one time. ChemStation allows the monitoring of 50 simultaneous ions, but monitoring more than 10-15 ions at the same time defeats the purpose of SIM and should be avoided.

14.6.4.1.1. Most SIM analyses monitor 3 to 8 ions simultaneously in a given time period or range. If more ions are

needed to do your analysis, try to separate them into SIM groups.

14.6.4.2. A SIM group is a group of simultaneously monitored ions. Only one group can be monitored at a given time, and the start time for group 2 becomes the end time for group 1. Using SIM groups, a Method can monitor the important ions for a list of compounds by switching from one group to another at the appropriate time during the chromatographic run. You would only look at the ions of interest, in the time range of interest.

14.6.5. Determining an appropriate dwell time

14.6.5.1. Once the fragments are chosen, the Mass Centroids are determined, and the ions grouped into SIM groups, you will need to set the dwell time for each group.

14.6.5.2. If your groups contain 2-5 ions, try 50msec as a first value for dwell time. To determine what adjustment needs to be made in the dwell time setting, you will need to run the Method once and examine the resulting data. The central goal in adjusting the dwell time is to optimize cycle time to get 15 to 20 points or scans across your chromatographic peak(s). Evaluate the data acquired with the dwell time set to 50msec, and determine what adjustment, if any, is required, as follows:

14.6.5.2.1. Load the data file acquired with your 50msec Method.

14.6.5.2.2. Determine the number of SIM cycles across your peak as follows:

14.6.5.2.2.1. Use the mouse to select a spectrum from the start of the peak (where the signal leaves the baseline).

14.6.5.2.2.2. Note and record the scan number of this spectrum.

14.6.5.2.2.3. Repeat for the end of the peak (where the signal approaches the base line).

14.6.5.2.2.4. The difference in these numbers is the number of SIM cycles over the peak.

14.6.5.2.3. If the number of cycles is less than 10, the dwell time needs to be reduced. If more than 25, increase the dwell time. Your goal should be about 15-20 points across most peaks.

14.7. Data Interpretation for SIM Analysis

14.7.1. The qualitative identification of target analytes determined by this method is based on the elution of the sample component at the same relative retention time (RRT) as the standard component, and the presence of the primary quant ion and at least one secondary qualitative ion.

14.7.2. Target analytes should be identified as present when:

14.7.2.1. The analyte is identified within the defined retention time window.

14.7.2.1.1. The RRT of the sample target analyte is within ±0.06 RRT units of the RRT of the standard target analyte.

14.7.2.2. The intensity of the primary quant ion is 100% and the secondary characteristic ion (and tertiary ion if used) is within the appropriate intensity ratio:

14.7.2.2.1. The relative intensities of the characteristic ions agree within 30% of the relative intensities of these ions in the reference spectrum.

14.7.2.3. Identification is hampered when sample components are not resolved chromatographically, fall outside of the retention time window due to a matrix effect, or are not confirmed by the presence of qualitative ions. Careful examination of the chromatogram by a chemist experienced in SIM analysis is critical.

14.7.3. When a compound has been identified, the quantitation of the compound will be based on the integrated abundance of the primary characteristic ion. Quantitation will take place using the internal standard technique. The internal standard used shall be the one nearest the retention time of that of a given analyte.

14.7.3.1. Identify and compute the concentration of each target analyte in the sample. The GC/MS data system is programmed to perform these functions.

15. CALCULATIONS

15.1. Response factors are calculated as follows:

$$RF = \frac{(A_x \times C_{is})}{(A_{is} \times C_x)}$$

where:
RF = response factor for target analyte being measured.
A_x = area of the characteristic ion for target analyte being measured.
A_{is} = area of the characteristic ion for the applicable internal standard.
C_{is} = concentration of the specific internal standard in ng/µL.
C_x = concentration of the target analyte being measured in ng/µL.

15.2. The percent relative standard deviation is calculated as follows:

$$\%RSD = \frac{SD}{RF_{ave}} \times 100$$

where: %RSD = percent relative standard deviation.
SD = standard deviation of the average RFs for the target analyte.
RF_{ave} = mean of the 5 initial RFs for the target analyte.

15.3. The relative retention time (RRT) is calculated as follows:

$$RRT = \frac{RT_c}{RT_{is}}$$

where: RRT = relative retention time of the target analyte.
RTc = retention time of the target analyte.
C_c = retention time of the nearest internal standard.

Note: Retention times must be in equivalent units.

15.4. The RPD between the sample and sample duplicate is calculated as follows:

$$RPD = \frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2}\right)} \times 100$$

where: RPD = relative percent difference between two measurements (C_1 & C_2).
C_1 = concentration of target analyte recovered in measurement 1.
C_2 = concentration of target analyte recovered in measurement 2.

Note: Concentrations must be in equivalent units.

15.5. The recovery of LCS compounds is calculated as follows:

$$\%REC_{LCS} = \left(\frac{C_{recovered}}{C_{added}}\right) \times 100$$

where: $\%REC_{LCS}$ = percent recovery of target analyte in LCS (or LCSD).
$C_{recovered}$ = concentration of target analyte recovered.
C_{added} = concentration of target analyte added.

Note: Concentrations must be in equivalent units.

15.6. Calculate the MDL as follows.

$$MDL = t \times S_{n-1}$$

where: MDL = method detection limit.
t = student's t value at a 99% confidence level with (n − 1) degrees of freedom. For seven replicate analyses, t = 3.14.
S_{n-1} = standard deviation of the (n − 1) replicate analyses.
n = number of replicate analyses.

16. METHOD PERFORMANCE

16.1. A demonstration of analytical capability shall be performed initially (prior to the analysis of any samples) and with a significant change in instrument type, personnel, matrix or test method.

16.2. Calibration protocols specified in Section 13, "Calibration and Standardization," shall be followed.

17. POLLUTION PREVENTION

17.1. The toxicity, carcinogenicity and other health hazards associated with the use of most laboratory chemicals have not been precisely defined. Each chemical should be handled assuming it is a potential health hazard.

17.2. Exposure to these chemicals should be minimized through the use of proper protective equipment and safe laboratory practices. In general, safety glasses, lab coats and gloves should be worn when handling chemicals.

17.3. The following additional precautions should be taken, as necessary, when handling high concentrations of hazardous materials:

17.3.1. A NIOSH approved air purifying respirator with cartridges appropriate for the chemical handled.

17.3.2. Extended length protective gloves.

17.3.3. Face shield.

17.3.4. Full-length laboratory apron.

17.4. Processes that promote vaporization of volatile chemicals should be performed in an area well ventilated to the exterior of the laboratory to prevent contamination to other areas in the laboratory.

17.5. When working with large amounts of volatile chemicals, the Coordinator must be cautious of the risk of high levels of volatile displacing the atmospheric air within the work area; therefore causing asphyxiation. Air purification respirators are ineffective in this situation and must not be used. The Coordinator must immediately vacate the area until ventilation has effectively reduced the concentration of volatiles.

18. DATA ASSESSMENT AND ACCEPTANCE CRITERIA

18.1. Method Blank:

18.1.1. Ideally, the concentration of target analytes in a MB should be less than the respective reporting limits (RLs). (less than ½ the RL for DOD work) If the concentration of any target analyte exceeds its RL, the source of contamination must be investigated and, if possible, eliminated. The acceptance criteria for MBs is as follows:

18.1.1.1. If a target analyte is found in the MB but not in the associated samples, report the sample and MB data without qualification.

18.1.1.2. If a target analyte is found in the MB and in the associated samples, evaluate the analyte in question to determine the effect

on the analysis of samples. Determine and eliminate the source of contamination.

18.1.1.3. Professional judgment should be exercised to determine if the data should be qualified or rejected and the samples re-extracted and/or re-analyzed.

18.2. LCS/LCSD:

18.2.1. All LCS/LCSD compounds must be within acceptance limits. If one or more LCS/LCSD compounds are not acceptable, the problem must be identified and corrected. Refer to Appendix 2 for current analytes and control limits.

18.2.2. If the LCS and/or LCSD %REC is outside of the acceptance limits high, the RPD is within acceptance limits, and all target analytes in the associated samples are not detected, the sample data can be reported without qualification.

18.3. Internal Standards:

18.3.1. Internal Standard Retention Times (RT) for Bromochloromethane, Chlorobenzene-d_5 and 1,4-Difluorobenzene in all samples and QC must be +/- 0.33 minutes.

18.3.2. The area response for each internal standard in all samples and QC must be within ±40% (Range: 60% to 140%) of the mean area response of the internal standards in the most recent initial calibration.

18.4. Surrogates:

18.4.1. The acceptance criteria for surrogate spike compound recoveries vary depending upon historical data. The upper and lower acceptance limits for each surrogate spike compound is based upon the historical average recovery ± 3S. The acceptance criteria for the surrogate compounds is currently as follows:

Analyte	% Recovery
1,4-Bromofluorobenzene	45-153
1,2-Dichloroethane-d4	37-163
Toluene-d8	73-121

18.4.2. If the surrogate compound recoveries are acceptable, report the surrogates and sample data without qualification.

18.4.3. If one or more surrogate recoveries are not acceptable, evaluation is not necessarily straightforward. The sample itself may produce effects due to such factors as interferences and high analyte concentration. This data alone cannot be used to evaluate the precision and accuracy of individual sample analyses. However, when exercising professional judgment, this data should be used in conjunction with other available QC information.

18.4.4. By itself, unacceptable surrogate recoveries do not invalidate sample data. The following must be accomplished if surrogate recoveries are not acceptable.

18.4.4.1. Check the internal standard and surrogate spiking mixture for degradation and contamination.

18.4.4.2. If the nonconformance is due to poor instrument performance or if the above actions fail to reveal the cause of the unacceptable surrogate(s) recovery, the same sample or extract should be re-analyzed.

18.4.4.3. If incorrect procedures or degraded/contaminated spiking solutions are determined to have not caused the unacceptable surrogate recoveries, the affected sample(s) must be re-analyzed or, if insufficient sample remains, reference made to the associated MB surrogate recoveries and the sample data reported with qualification.

18.4.4.3.1. If, upon re-analysis, the surrogates remain unacceptable, matrix interference can be cited and reference made to the associated MB surrogate recoveries and the sample data reported with qualification.

18.4.4.3.2. If the MB surrogates are unacceptable, all associated sample data must be invalidated and all associated samples re-analyzed.

18.5. Additional information regarding internal quality control checks is provided in SOP-T020.

18.6. All concentrations shall be reported in ppb (v/v). Units may be reported in ppm (v/v), ug/l or ug/m^3, on a project specific basis.

18.7. The data reported shall adhere to the significant figures, rounding, and data reporting procedures outlined in the current revision of SOP-T009.

19. CORRECTIVE ACTIONS

19.1. If on the basis of internal or external systems or performance audits, routine monitoring of laboratory support equipment, or QC sample analysis results, analytical systems fail to meet the established criteria, an appropriate corrective action must be implemented.

19.2. The Operations Manager, Project Manager, Quality Assurance Manager, Group Leader and analyst may be involved in identifying the most appropriate corrective action. If previously reported data are affected or if corrective action will impact the project budget or schedule, the action may directly involve the Laboratory Director.

19.3. Corrective actions are generally of two types, immediate and long-term actions.

19.3.1. An **immediate action** is designed to correct or repair nonconforming instruments and measurement systems. The analyst or Group Leader as a result of calibration checks and other QC sample analyses most frequently will identify the need for such an action.

19.3.2. A **long-term action** is designed to eliminate causes of nonconformance. The need for such actions is identified by systems and performance audits. The systematic nonconformances identified during the data generation process and the appropriate corrective measures taken are thoroughly documented in the Corrective Action Record. Examples of this type of action include:

19.3.2.1. Remedial training of staff in technical skills, technique or implementation of operating procedures.

19.3.2.2. Rescheduling of analytical laboratory routine to ensure analysis within holding times.

19.3.2.3. Revision of standard operating procedures.

19.3.2.4. Replacing personnel, as necessary.

19.4. For either type of corrective action, the sequential steps that compose a close-loop corrective action system are as follows:

19.4.1. Define the problem.

19.4.2. Assign responsibility for investigating the problem.

19.4.3. Investigate and determine the cause of the problem.

19.4.4. Assign and accept responsibility for implementing the corrective action.

19.4.5. Determine effectiveness of the corrective action and implement correction.

19.4.6. Verify that the corrective action has eliminated the problem.

19.5. Depending on the nature of the problem, the corrective action employed may be formal or informal. In either case, occurrence of the problem, the corrective action employed, and verification that the problem has been eliminated must be properly documented on a Corrective Action Record.

20. CONTINGENCIES FOR OUT-OF-CONTROL OR UNACCEPTABLE DATA

20.1. Out-of-control data are reviewed and verified by the Group Leader of the appropriate department. All samples associated with an unacceptable QC set is then subject to reanalysis, depending upon the QC type in question.

20.1.1. LCS/LCSD: Because they denote whether the analytical system is operating within control, it is imperative that the LCS recoveries obtained are within acceptability criteria. If the recoveries fail for a given reported compound, the technical director confirms the unacceptable result.

20.1.1.1. If the LCS results are verified as acceptable, no corrective action is required.

20.1.1.2. If the LCS result is verified as out-of-control, and the subject compound is to be reported in samples within that analytical batch, the samples reported with that failed compound must be reanalyzed with a valid LCS recovery for the compound.

20.1.1.3. If the LCS result is verified as out-of-control, and the subject compound is NOT to be reported in the samples within that analytical batch, the samples are not subject to reanalysis. No corrective action is required for that batch.

21. WASTE MANAGEMENT

21.1. The proper disposal of analytical samples and laboratory wastes is regulated by a variety of local, state, and federal laws. In order to remain compliant with these laws, and at the same time keep sample disposal costs at a minimum, the samples and wastes are identified, segregated, and either returned to the client or placed into the proper laboratory waste stream, if applicable.

21.2. Each specific laboratory area shall maintain clearly labeled satellite waste containers for small quantity waste collection. These waste containers shall be used for temporary collection of residual sample from aliquotting procedures, contaminated consumables, sample extracts, purged aqueous samples, and other wastes that require disposal as hazardous waste, if applicable.

21.3. All laboratory personnel must be aware of the types of chemicals they are using and the appropriate procedures for their disposal, if applicable.

21.4. To ensure compliance with Federal RCRA regulations, the Hazardous Waste Coordinator collects and disposes of the hazardous waste at each satellite collection point no less than monthly, if applicable.

21.5. Waste management procedures shall adhere to the current revision of SOP-T005, "Disposal of Laboratory Samples and Waste."

22. REFERENCES

22.1. US EPA, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, January 1997, Method TO-15, "The Determination of Volatile Organic Compounds (VOCs) in Air Collected in Summa® Canisters and Analyzed by Gas Chromatography/Mass Spectrometry".

http://www.epa.gov/ttnamti1/files/ambient/airtox/to-15r.pdf

http://www.epa.gov/ttnamti1/files/ambient/airtox/TO-15-Supplement.pdf

22.2. www.chem.agilent.com/Library/Support/Documents/a05042.pdf - Setting up a SIM acquisition method – MS ChemStation-Agilent

23. TABLES, DIAGRAMS, FLOWCHARTS AND VALIDATION DATA

23.1. Appendix 1: Table 1 and Table 2: Ions for Qualitative Identification of Standard and Additional Target Compounds.

23.2. Appendix 2: Standard Analyte, Reporting, Method Detection and Control Limits for TO-15SIM.

24. MODIFICATIONS

Calscience SOP M393 Section	Reference Document Standard Methods Section	Summary of Modification
All	All	Use of SIM Mode

25. REVISION HISTORY

Revision	Description	Author	Effective Date
0.0	SOP Creation	R. McHale	08/01/2011
1.0	Revisions: Section 3: Detection Limits Section 6: Definitions Section 9: Equipment / Supplies Section 10: Reagents and Standards Section 12: Quality Control Section 13: Calibration and Standardization	E. Winger	03/11/2013

APPENDIX 1

Table I : Ions for Qualitative Identification of Standard Target Compounds

Routine Analyte	Qlon E	2nd	3rd
Chloromethane	50	52	
1,1-Difluoroethane	51	65	
c-1,2-Dichloroethene	61	96	
t-1,2-Dichloroethene	61	96	
1,2-Dichloroethane	62	98	
Vinyl Chloride	62	64	
1,1-Dichloroethane	63	65	
Chloroethane	64	66	
1,2-dichloroethane-d4 (surr)	65	67	
Methyl-tert-Butyl Ether	73	57	
Benzene	78	77	
Chloroform	83	85	
1,1,2,2-Tetrachloroethane	83	85	
Bromodichloromethane	83	85	
Methylene Chloride	84	86	
Dichlorodifluoromethane	85	87	
Toluene	91	92	
Ethylbenzene	91	106	
p/m-Xylene	91	106	
o-Xylene	91	106	
1,4-Bromofluorobenzene (surr)	95	174	176
1,1-Dichloroethene	96	98	
1,1,1-Trichloroethane	97	63	
1,1,2-Trichloroethane	97	83	
Toluene-d8 (surr)	98	100	
Trichlorofluoromethane	101	103	
1,1,2-Trichloro-1,2,2-Trifluorethane	101	151	
4-Ethyltoluene	105	120	
1,3,5-Trimethylbenzene	105	120	77
1,2,4-Trimethylbenzene	105	120	77
Chlorobenzene	112	77	
1,4-Difluorobenzene (IS)	114	---	
Chlorobenzene-d5 (IS)	117	---	
Carbon Tetrachloride	117	119	
Dibromochloromethane	129	127	
Trichloroethene	130	132	
Bromochloromethane (IS)	130	---	
Tetrachloroethene	166	164	131
Hexachloro-1,3-Butadiene	225	227	223

APPENDIX 1, Cont'd

Table 2 : Ions for Qualitative Identification of Additional Target Compounds

Non-Routine Analyte	Qlon E	2nd	3rd
2-Butanone	43	42	72
Ethanol	45	46	43
Isopropanol	45	43	
1,3-Butadiene	54	39	
Cyclohexane	56	84	
Acetone	58	43	
4-Methyl-2-Pentanone	58	85	
2-Hexanone	58	43	
1,2-Dichloropropane	63	62	41
c-1,3-Dichloropropene	75	39	
t-1,3-Dichloropropene	75	39	
Carbon Disulfide	76	44	78
Dichlorotetrafluoroethane	85	135	87
Hexane	57	43	41
1,4-Dioxane	88	58	
Benzyl Chloride	91	106	65
Bromomethane	94	96	
Heptane	100	43	71
Styrene	104	78	
1,2-Dibromoethane	107	109	
Naphthalene	128	127	
1,2-Dichlorobenzene	146	148	
1,3-Dichlorobenzene	146	148	
1,4-Dichlorobenzene	146	148	
Bromoform	173	170	174
1,2,4-Trichlorobenzene	180	182	

APPENDIX 2

Standard Analyte, Reporting, Method Detection and Quality Control Limits

Routine Analyte	CAS #	RL ppbv	MDL ppbv	LCS/LCSD % REC	LCS/LCSD % RPD
Benzene	71-43-2	0.025	0.0007	50-150	0-30
Bromodichloromethane	75-27-4	0.025	0.0013	50-150	0-30
Carbon Tetrachloride	56-23-5	0.025	0.0008	7-187	0-31
Chlorobenzene	108-90-7	0.025	0.0028	50-150	0-30
Chloroethane	75-00-3	0.025	0.0011	50-150	0-30
Chloroform	67-66-3	0.025	0.001	50-150	0-30
Chloromethane	74-87-3	0.025	0.0017	50-150	0-30
Dibromochloromethane	124-48-1	0.025	0.0007	50-150	0-30
Dichlorodifluoromethane	75-71-8	0.025	0.001	50-150	0-30
1,1-Dichloroethane	75-34-3	0.025	0.0022	50-150	0-30
1,1-Dichloroethene	75-35-4	0.025	0.0011	50-150	0-30
1,2-Dichloroethane	107-06-2	0.025	0.0008	28-166	0-40
c-1,2-Dichloroethene	156-59-2	0.025	0.0008	35-165	0-35
t-1,2-Dichloroethene	156-60-5	0.025	0.0007	50-150	0-30
Ethylbenzene	100-41-4	0.025	0.0005	27-153	0-46
4-Ethyltoluene	622-96-8	0.025	0.0006	27-153	0-34
Hexachloro-1,3-Butadiene	87-68-3	0.025	0.0008	50-150	0-30
Methyl-t-Butyl Ether (MTBE)	1634-04-4	0.025	0.0009	50-150	0-30
Methylene Chloride	75-09-2	0.025	0.0012	50-150	0-30
o-Xylene	95-47-6	0.025	0.0005	22-160	0-48
p/m-Xylene	179601-23-1	0.025	0.0011	21-165	0-51
Tetrachloroethene	127-18-4	0.025	0.0009	34-154	0-33
Toluene	108-88-3	0.025	0.0007	28-154	0-42
Trichloroethene	79-01-6	0.025	0.0008	43-139	0-31
Trichlorofluoromethane	75-69-4	0.025	0.001	50-150	0-30
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	0.025	0.0009	50-150	0-30
1,1,1-Trichloroethane	71-55-6	0.025	0.0008	50-150	0-30
1,1,2-Trichloroethane	79-00-5	0.025	0.0008	27-171	0-38
1,3,5-TrimethylBenzene	108-67-8	0.025	0.0007	50-150	0-30
1,1,2,2-Tetrachloroethane	79-34-5	0.025	0.0013	50-150	0-30
1,2,4-TrimethylBenzene	95-63-6	0.025	0.0008	50-150	0-30
Vinyl Chloride	75-01-4	0.025	0.0028	44-140	0-33

APPENDIX D

HEALTH AND SAFETY PLAN

APPENDIX D
HEALTH AND SAFETY PLAN
VAPOR INTRUSION ASSESSMENT IMPLEMENTATION
Santa Clara, California

Prepared For:

Texas Instruments
2900 Semiconductor Way
Santa Clara, California

Prepared By:

Langan Treadwell Rollo
555 Montgomery Street, Suite 1300
San Francisco, California 94111

9 April 2014
750620701

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VAPOR INTRUSION ASSESSMENT
IMPLEMENTATION
Santa Clara, California

1.0 INTRODUCTION

1.1 General

This Health and Safety Plan (HSP) has been developed by Langan Treadwell Rollo, (Langan) to comply with Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1910.120(b)(4), Hazardous Waste Operations and Emergency Response. It addresses the foreseeable activities associated with the vapor intrusion investigation to be conducted at the Texas Instrument, Inc., (TI) Santa Clara Campus located at 2900 Semiconductor Way in Santa Clara, California (Site) (Figure 1).

This HSP will be implemented by Langan personnel while on site. Compliance with this HSP is required of all Langan personnel and third parties who enter this area of site operations. The management of the day-to-day activities concerning this Site and implementation of this HSP in the field is the responsibility of the Site Health and Safety Officer (HSO). Assistance in the implementation of this HSP can also be obtained from the Langan Health and Safety Manager (HSM). The content of this HSP may change or undergo revision based upon additional information made available to health and safety personnel, Site conditions, monitoring results, or changes in the scope of work. Any changes proposed must be reviewed by H&S staff and are subject to the approval of the Langan's HSM.

1.2 Site Location and Background

The TI Santa Clara Campus is generally bounded by Kifer Road to the south, the Sunnyvale/Santa Clara border to the west, San Ysidro Way to the east and Central Expressway to the north (Figure 1). The Site is surrounded by light industrial manufacturing and commercial property, with residential areas about 1 mile north of the Site boundary.

Semiconductors were designed and manufactured at the Site from 1967 until 1999. The campus is now devoted entirely to office, labs, and support services. Currently, there is no manufacturing at the Site.

In July 1987, the Site was listed on the National Priorities List (NPL) of sites subject to regulation under the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as the federal "Superfund" act). TI's environmental remediation programs are administered by the Regional Water Quality Control Board (RWQCB), which is the lead agency for the Site (APN 205-38-021) under formal agreement with the U.S. Environmental Protection Agency (EPA). The Final Site Cleanup Requirements for Operable Unit 1 (OU1) are detailed in RWQCB Orders 91-137, 91-139, and 91-140, and the EPA Record of Decision, which were issued in September 1991.

1.3 Description of Tasks

The soil vapor intrusion survey at Buildings A, B, C, G, M, W and 39 will include the following onsite work tasks:

- Task 1: Conduct building survey and inventory
- Task 2: Conduct sub-slab soil gas sampling
- Task 3: Conduct indoor air and ambient air sampling

2.0 IDENTIFICATION OF KEY PERSONNEL/HEALTH AND SAFETY PERSONNEL

The following briefly describes the health and safety designations and general responsibilities which may be employed for this phase of work. The titles have been established to accommodate the site needs and requirements in order to ensure the safe conduct of onsite work. The number and type of H&S personnel for a given work location will be based upon the particular H&S requirements relative to the proposed site activities or operations.

2.1 Project Manager (Joshua Graber): Phone 415-254-8774

The Project Manager is Joshua Graber. As Project Manager, his responsibilities include:

- Ensuring that this HSP is developed and approved prior to conducting onsite activities;

- Ensuring that all the tasks in the project are performed in a manner consistent with Langan's comprehensive Health and Safety Program for Hazardous Waste Operations and this HSP;
- Monitoring site hazards and conditions;
- Knowing (and ensuring that all site personnel also know) emergency procedures, evacuation routes, and the telephone numbers of the ambulance, local hospital, poison control center, fire department, and police department; and
- Participating in the implementation of this HSP.

2.2 Health and Safety Officer (Mukta Patil): Phone 858-336-0019

The HSO is Mukta Patil. If Mukta Patil is not able to perform field activities then an alternate HSO (Christina Simmons or Adam Brown) will be assigned depending on the nature of the field activity. HSO responsibilities include:

- Participating in the development and implementation of this HSP;
- Conducting Jobsite Safety Inspections (Appendix D1) and correcting any shortcomings in a timely manner;
- Helping to select proper Personal Protective Equipment (PPE) and periodically inspecting it;
- Ensuring that PPE is properly stored and maintained;
- Controlling entry into and exit from the contaminated areas or zones of the Site;
- Monitoring the work parties for signs of stress, such as heat stress, fatigue, and cold exposure;
- Monitoring Site hazards and conditions;
- Knowing (and ensuring that all Site personnel also know) emergency procedures, evacuation routes, and the telephone numbers of the ambulance, local hospital, poison control center, fire department, and police department; and

- Resolving conflicting situations which may arise concerning safety requirements and working conditions.

2.3 Corporate Health and Safety Manager (Anthony Moffa): Phone 215-491-6545

The Corporate HSM is Anthony Moffa. His responsibilities include:

- Serving as a resource in the development and implementation of HSPs;
- Providing guidance and serving as a resource to the HSO.
- Assisting the Site HSO with development of the HSP, updating HSP as dictated by changing conditions, jobsite inspection results, etc.;
- Assisting the HSO to conduct Jobsite Safety Inspections and assisting with correction of measures as necessary;
- Ensuring training requirements are satisfied in a timely manner; and
- Ensuring medical evaluations of personnel are current.

2.4 Subcontractor Responsibilities

The use of subcontractors is not anticipated. Should a subcontractor be used, the subcontractor shall develop and implement their own HSP, which identifies a lead individual responsible for H&S compliance for each of their employees and subcontractors, if applicable. The subcontractor's HSP will be at least as stringent as this Langan HSP. The subcontractor must be familiar with and abide by the requirements outlined in their own HSP. A subcontractor may elect to adopt Langan's HSP as its own provided that it has given written notification to Langan, but where Langan's HSP excludes provisions pertinent to the subcontractor's work; the subcontractor must provide written addendums to this HSP. Additionally, the subcontractor must:

- Ensure their employees are trained in the use of all appropriate PPE for the tasks involved;
- Notify Langan of any hazardous material brought onto the job Site, the hazards associated with the material, and must provide a MSDS for the material;

- Have knowledge of, understand, and abide by all current federal, state, and local health and safety regulations pertinent to the work;
- Ensure their employees have received current training in the appropriate levels of 29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response* (HAZWOPER);
- Ensure their employees have been medically cleared to work in Hazardous Waste Sites and to wear a respirator, if necessary;
- Ensure their employees have been fit-tested within the year on the type respirator they will wear;
- Ensure that its employees have been briefed on this HSP and have signed the Compliance Agreement (Section 13.0).
- Ensure that its employees will accomplish all work in a safe environment and immediately report any hazards identified to the HSOs.

3.0 TASK/OPERATION SAFETY AND HEALTH RISK ANALYSES

This section provides an assessment of the general hazards that may be encountered during field work activities at the Site through a task-by-task risk analysis. Potential hazards, generally categorized as chemical exposure and physical hazards are addressed below.

3.1 Chemical Exposure Hazards

No chemicals are anticipated for use onsite as part of this investigation; however, volatile organic compounds may be encountered due to onsite contamination during soil vapor sampling (Table 1). To date, the following compounds have been identified in onsite subsurface materials (soil and groundwater):

- 1,1,1-trichloroethane (1,1,1-TCA)
- 1,1,2-trichloroethane
- 1,1-dichloroethane (1,1-DCA)
- 1,1-dichloroethene (1,1-DCE)
- 1,2-dichlorobenzene
- 1,2-dichloroethane
- 1,4-dichlorobenzene
- chlorobenzene
- chloroethane (ethyl chloride)
- chloroform
- cis-1,2-dichloroethene (cis-1,2-DCE)
- dichloromethane (methylene chloride)
- tetrachloroethene (PCE)
- trans-1,2-dichloroethene
- trichloroethene (TCE)
- trichlorofluoromethane (Freon 11)
- trichlorotrifluoroethane (Freon 113)
- vinyl chloride
- Ethylbenzene
- m,p-xylenes
- o-xylene
- toluene

Additional information about the above potential contaminants of concern can be found in the information sheets provided in Appendix D2.

3.2 Physical Hazards

Physical hazards which may be encountered during investigation activities at this Site include:

- Biological (insects, animals, etc.)
- Safety (slip, trip & fall hazards, sharp objects, lifting, use of PPE, heavy equipment, etc.)
- Electrical (buried cables, electrical equipment, etc.)
- Heat stress (major hazard from wearing protective clothing)
- Cold exposure (low temperatures and wind chill and impaired ability to work are the dangers)
- Noise (heavy equipment being the main source)

Lists of physical hazards, which may be encountered during site operations for this project, are also included in Table 1.

3.3 Task-By-Task Risk Analysis

Through information gathering, inspection, and monitoring, hazards that are potentially present have been determined for each specific task described in Section 1.3. Table 1 provides a summary of chemical exposure and physical hazards that could potentially be encountered by personnel during each task effort. Additionally, Job Safety Analyses (JSAs) have been prepared and are located in Appendix D3.

4.0 PERSONNEL TRAINING

4.1 Basic Training

Completion of an initial 40-hour HAZWOPER training program (or its equivalent) as detailed in OSHA's 29 CFR 1910.120(e) is required for all employees who will perform work in areas where the potential for a chemical exposure exists. Annual 8-hour refresher training is also required to maintain competencies to ensure a safe work environment.

4.2 Site-Specific Training

Site-Specific Training provided by Langanfor its field staff will specifically address the activities, procedures, monitoring, and equipment for the site operations. It will include Site and facility layout, hazards, and emergency services at the Site, and will detail all the provisions contained within this HSP. Specific issues that will be addressed include the hazards described in Section 3.0.

4.3 Safety Briefings

Project personnel will be given briefings by the Site HSO on a daily and on an as-needed basis to further assist site personnel in conducting their activities safely. Briefings will be provided when new activities are to be conducted, changes in work practices must be implemented due to new information made available, or if Site or environmental conditions change. Briefings will also be given to facilitate conformance with prescribed safe practices when performance deficiencies are identified during routine daily activities or as a result of jobsite safety inspections. The Safety Briefings Form (Appendix D4) should be used for this purpose.

5.0 MEDICAL SURVEILLANCE

5.1 Fitness for Duty

All personnel who will be performing field work involving potential exposure to toxic and hazardous substances will be required to have passed an initial baseline medical examination, with annual follow-up medical exams thereafter, consistent with 29 CFR 1910.120(f). Medical evaluations will be performed by, or under the direction of, a physician board-certified in occupational medicine.

Additionally, personnel who may be required to perform work while wearing a respirator must receive medical clearance to do so, consistent with 29 CFR 1910.134(e), *Respiratory Protection*. Again, medical evaluations will be performed by, or under the direction of, a physician board-certified in occupational medicine.

6.0 AIR MONITORING

6.1 General

It will be necessary to monitor the atmospheric conditions during onsite work activities to identify and quantify the presence of volatile organic compounds as airborne contaminants; to assist in defining work zones; and, to determine the level of work protection needed. Air monitoring must be performed wherever the possibility of worker exposure to hazardous substances exists. Langan will perform air monitoring at the worker's breathing zone for Langan personnel during sub-slab and near-slab soil vapor sampling. Air monitoring will be conducted using a photo-ionization detector (PID). Air monitoring results will be made available to subcontractors for review. Upgrades/downgrades to personal protective equipment (PPE) will be made based on air monitoring results in the breathing zone. In general, work shall be initiated in a Level D PPE (safety vest and safety shoes/boots) with a contingency to upgrade the level of PPE based on action levels. If an exceedance of action levels triggers a PPE upgrade, Langanwill notify subcontractors of the condition.

6.2 Instrumentation and Action Levels

A PID (ppbRAE Plus 10.6 eV UV lamp) will be used to evaluate action levels. Table 2 provides a summary explanation of monitoring equipment. The PID will be used in areas known to contain VOCs during ground intrusive activities (i.e., sub-slab soil vapor sampling). All applicable

instruments will be calibrated before each use. Readings will be recorded on the Instrumentation Calibration Log (Appendix D5). Before any field activities commence, the background levels of the Site be monitored and recorded away from the areas of potential contamination to obtain accurate results. All Site readings will be recorded on the Air Monitoring Record (Appendix D6). Instrument action levels for monitored gases are provided in Table 3. The calculated action level for vinyl chloride ($\frac{1}{2}$ the OSHA PEL adjusted using correction factors for a ppbRAE Plus PID) is the most-conservative action level (lowest); therefore, the vinyl chloride action level (1000 ppb) will be used as the Site-specific action level. Note that this action level must be adjusted if another PID model or PID lamp intensity is used.

7.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

7.1 Levels of Protection

PPE must protect workers from the specific hazards they are likely to encounter onsite. Selection of the appropriate PPE must take into consideration: (1) identification of the hazards or suspected hazards; (2) potential exposure routes; and, (3) the performance of the PPE construction (materials and seams) in providing a barrier to these hazards. Based on anticipated Site conditions and the proposed work activities to be performed at the Site, Level D Protection will be used. The upgrading/downgrading of these levels of protection will be based on continuous air monitoring results as described in Section 6.0. The decision to modify standard PPE will be made by the Site HSO after conferring with the Project Manager. Level D protection is described below.

- **Level D Protection**
  a. Safety glasses (as necessary)
  b. Safety glasses w/sideshields or chemical splash goggles (as necessary)
  c. Safety boots/shoes (toe-protected)
  d. Coveralls (Tyvek or equivalent, if necessary)
  e. Hard hat (wherever overhead work, as necessary)
  f. Long-sleeve work shirt and work pants
  g. Nitrile gloves (as necessary)
  h. Hearing protection (as necessary)
  i. Cut-resistant gloves (as necessary)

- **Level C Protection**
  a. Full face-piece, air-purifying, cartridge*-equipped, NIOSH-approves respirator [*combo cartridge P100/OV/CL/HC/SD/CD/HS (escape)]
  b. Inner (latex) and outer (nitrile) chemical-resistant gloves
  c. Chemical-resistant safety boots/shoes (toe-protected)
  d. Hard hat (as necessary)
  e. Long sleeve work shirt and work pants
  f. Coveralls (Tyvek or equivalent)
  g. Hearing protection (as needed)
  h. Cut-resistant gloves (as needed)

The action levels used in determining the necessary levels of respiratory protection and upgrading PPE are summarized in Table 3. The written Respiratory Protection Program is maintained by the HSM and is available as needed. The monitoring procedures and equipment are outlined in Section 6.0.

8.0 SITE CONTROL

8.1 Site Communications Plan

Verbal communications will be the primary method of communication used at the Site during the investigation. Cell phones shall be used to the extent practical by field teams for communication between downrange operations and the command post base station. In the instances where verbal communication cannot be used, such as when working in respiratory protective equipment, hand signals will be used. It may also be necessary to use these signals when working around noisy heavy equipment. Hand signals will be covered during site-specific training.

Hand signals and their message are described in the following table:

Hand Signal	**Meaning**
Hand gripping throat	Out of air; cannot breathe
Grip partners wrists or place both hands around waist	Leave immediately without debate
Hands on top of head	Need assistance
Thumbs up	OK; I'm alright; I understand
Thumbs down	No; negative
Simulated "stick" break with fists	Take a break; stop work

8.2 Work Zones

The need to formally establish specific work zones (Support, Contamination Reduction, and Exclusion Zones) during Site activities will be determined by the HSO. A general description of these work zones is provided in Figure 3. It is important for the safety of all concerned that appropriate barriers (cones, barricades, caution tape etc.) are in place to keep vehicles and pedestrians away from the Work Zone.

8.3 The Buddy System

Workers will use the "buddy system," teams of two, for all work activities to ensure that rapid assistance can be provided in the event of an emergency. This requires work groups to be organized such that workers can remain close together and maintain visual contact with one another. Workers using the "buddy system" have the following responsibilities:

- Provide his/her partner with assistance
- Observe his/her partner for signs of stress
- Periodically check the integrity of his/her partner's PPE
- Notify the HSO or other Site personnel if emergency service is needed

8.4 In Case of Emergency

In case of emergency notify the Texas Instrument's Emergency Response Team **(DIAL 1-6000).** Notify the HSO and Project Manager immediately.

8.5 Nearest Medical Assistance

The address and telephone number of the nearest hospital:

Kaiser Permanente
700 Lawrence Expressway
Santa Clara, CA 95051
(408) 236-6400
or Dial 911

Map with directions to the hospital are shown in Figure 4. This information must be posted prominently at the Site, and should always be available to all personnel at all times.

8.6 Safe Work Practices

The standing orders, safe work practices that must always be followed while on Site, are shown in Table 5. Many are common sense in nature. The Site HSO has responsibility for enforcing these practices which shall be made available to personnel at all times. Those who do not abide by these safe work practices will be removed from the Site.

8.7 Site Security

Special site security measures are not anticipated. The need for additional security measures will be determined by the HSO based on observations during the implementation of the field activities.

9.0 DECONTAMINATION PLAN

9.1 General

All personnel, clothing, equipment, and samples leaving contaminated areas of the Site must be decontaminated. Decontamination for this operation is achieved through physical removal and chemical detoxification/disinfection/sterilization. The first step in decontamination is prevention. Standard operating procedures have been established to minimize contact with wastes:

- Work habits that minimize contact with wastes are stressed;

- Disposable sampling equipment, where appropriate, will be used.

9.2 Decontamination Procedures

Standard decontamination procedures will be used as described in Appendix D7.

9.3 Disposal of Decontamination Wastes and Investigation-Derived Waste

Wastewater solutions from the decontamination of the boring equipment, augers, hand tools, sampling equipment, etc. will be collected, characterized, and disposed of properly. Decontamination wastewater will be stored in tightly-sealed, well-marked 55-gallon steel drums and staged in preparation for disposal by the disposal contractor. Other investigation derived waste (i.e., used-gloves shall be double-bagged and properly disposed of offsite).

10.0EMERGENCY RESPONSE

10.1 General

Because of the hazards that may be present at the Site, and the conditions under which operations are conducted, it is possible that an emergency situation may develop. Emergency situations can be characterized as injury or chemical exposure to personnel, fire or explosion, environmental release, or serious weather conditions.

10.2 Responsibilities

Site Emergency Coordinator - The HSO, or his/her alternate, will serve as the Site Emergency Coordinator and shall implement emergency procedures whenever conditions warrant such action. The Site Emergency Coordinator will be responsible for assuring the evacuation, emergency treatment, emergency transport of site personnel, and notification of emergency units and the appropriate management staff. Emergency response instructions will be provided by the HSO as part of every employee's training prior to the start of work.

Employees - All employees are familiar with emergency response procedures for this work location.

10.3 Evacuation

In the event of an emergency situation, an air horn or vehicle horn will be sounded three (3) times indicating the initiation of evacuation procedures. Loud voice command, if appropriate,

can be used. All personnel will evacuate and assemble at the Site entrance. No one, except the emergency responders, will be allowed to proceed into the area once the emergency signal has been given. The Site Emergency Coordinator will ensure that access for emergency equipment is provided and that all sources of combustion (e.g., operating machinery, etc.) have been shut down once the alarm has been sounded. Wind direction will be taken into consideration for evacuation plans. Evacuation plans will be discussed at the initial Site-Specific Training and as needed at the regular safety briefings.

In all situations, when an onsite emergency results in an evacuation, personnel shall not re-enter until:

1. The conditions resulting in the emergency have been corrected.
2. The hazards have been reassessed.
3. This HSP has been reviewed.
4. Site personnel have been briefed on any changes to this HSP.
5. The Owner (TI) has approved re-entrance.

10.4 Emergency Contacts/Notification System

The fire department and other emergency response groups will be notified by telephone of the emergency as soon as possible. An emergency telephone numbers list is provided as Table 4 in this HSP. This list will also be posted prominently at the Site and made readily available to personnel at all times.

Langan requires that all property damage and injuries of any personnel (Langan employees, subcontractors, property owners, Site visitors, etc) associated with the field activities be reported immediately to Langan (i.e. the Langan PM, HSM, or HSO).

10.5 Emergency Medical Treatment

Personnel Injury - In case of injury to personnel, immediately administer emergency first aid. A First Aid kit is located in the Langan vehicle and at the Site. The ambulance/rescue squad shall be contacted as necessary. Some situations may require transport of the injured parties by automobile. Therefore, maps/directions to the nearest hospital are provided on Table 4 and

Figure 4. Figure 4 will also be posted at the Site and made readily available to personnel at all times.

Personnel Exposure - Emergency first aid procedures to be followed are:

Skin Contact:	Use copious amounts of soap and water. Wash/rinse affected areas thoroughly, and then provide appropriate medical attention. Rinse eyes with water for at least 15 minutes.
Inhalation:	Move to fresh air and/or, if necessary decontaminate/transport to hospital.
Ingestion:	Decontaminate and transport to emergency medical facility.
Puncture/Laceration:	Decontaminate, if possible, and transport to emergency medical facility.

10.6 Fire or Explosion

Appropriate fire extinguishers will be made available at the Site for trained personnel to use on incipient stage fires without endangering the safety and health of those nearby. If the use of fire extinguishers will not extinguish the fire, immediately notify the fire department, sound the evacuation signal, and then evacuate the area, assembling at the site entrance to be accounted for and to receive further instructions.

10.7 Spills/Leaks

Control or stop the spread of minor chemical spills contamination utilizing the appropriate materials (absorbents, etc.), if possible. If the release is significant, or highly hazardous, immediately notify the appropriate response groups, sound the evacuation signal, evacuate the area, and assemble at the site entrance to be accounted for and to receive further instructions.

10.8 Adverse Weather Conditions

In the event of heavy precipitation (i.e. rain,), conditions will be assessed on Site to determine if the work can proceed safely. If it is determined that the weather poses a significant hazard, Site operations will be stopped and rescheduled. Some of the items to be considered prior to evaluating if work should continue include:

- potential for heat stress and heat-related injuries;
- potential for cold stress and cold-related injuries;
- treacherous weather-related working conditions;
- limited visibility;
- high wind conditions.

Information on cold-stress and cold-related injuries and heat stress and heat-related injuries is provided in Appendix D8, the National Safety Council Emergency First Aid Guide.

10.9 Documentation and Notification

Immediately following an incident or near miss, unless emergency medical treatment is required, either the employee or a coworker must contact the Langan Incident/Injury Hotline at 201-398-4699 and the client representative to report the incident or near miss. A written report must be completed and submitted to the client representative within 24 hours of the incident. For emergencies involving personnel injury and/or exposure, employee will complete and submit the Langan Incident/Injury Report (Appendix D9) to the Langan Corporate Health and Safety Manager as soon as possible following the incident.

The only exception to this requirement is if only two Langan people are onsite and emergency medical treatment (pressure on a wound, emergency eye wash/shower, etc) and ambulance transport is needed. The primary focus shall be on the injured person's welfare, getting them the necessary medical treatment. If allowed, the non-injured person shall ride in the ambulance with the injured person and contact Langan/TI representative only after the injured person has been received at the hospital and is undergoing treatment. Contact information for these individuals is included on Table 4, which is required to be posted.

The fire department and other emergency response groups will be notified by telephone of the emergency as soon as possible. An emergency telephone numbers list is provided in Table 4 of this HSP, which is required to be posted.

11.0 HSP APPROVALS

By their signature, the undersigned certify that this HSP is approved.

Joshua Graber, Project Manager (HSO)	**Date**
Mukta Patil, Site Health & Safety Officer (HSO)	**Date**
Anthony Moffa, Health & Safety Manager (HSM)	**Date**

12.0 HSP COMPLIANCE AGREEMENTS

All Langan field personnel and subcontractors will sign this HSP Compliance Agreement indicating that they have become familiar with this HSP, and that they understand it and agree to abide by it.

Printed Name	Signature	Company	Date

TABLES

TABLE 1
SUMMARY OF THE CHEMICAL AND PHYSICAL HAZARDS
ASSOCIATED WITH EACH TASK

VAPOR INTRUSION INVESTIGATION IMPLEMENTATION
Santa Clara, California

TASK IDENTIFICATION:

1 = Task 1: Conduct building survey and inventory
2 = Task 2: Conduct sub-slab soil gas sampling
3 = Task 3: Conduct indoor air and ambient air sampling

ABBREVIATIONS

Abs = Skin absorption
anes = anesthesia
anor = anorexia
[carc], Ca = potential occupational carcinogen
CNS = Central Nervous System
con = skin and/or eye contact
conf = confusion
constip = constipation
convuls = convulsions
corn = corneal
depres = depressant/depression
derm= dermititis
diarr = diarrhea
dizz = dizziness
drow = drowsiness
dysp = dyspnea (breathing difficulty)
euph = euphoria
ftg = fatigue
GI = gastrointestinal
gidd = giddiness
head = headache
hema = hematuria (blood in urine)
hemog = hemoglobinuria
hyperpig = hyperpigmentation
IDLH = Immediately Dangerous to Life and Health
inco = incoordination
ing = ingestion
inh = inhalation
insom = insomnia
irrit = irritation
jaun = jaundice
lac = lacrimation (discharge of tears)
lass = lassitude (weakness, exhaustion)
low-wgt = weight loss
mal = malaise (vague feeling of discomfort)
malnut = malnutrition
mg/m3 = milligram per cubic meter
muc memb = mucous membrane
musc = muscle
narco = narcosis
ner = nervousness
N.D. = Not Determined
pares = paresthesia
perineur = peripheral neuropathy
PID = Photoionization Detector
ppm = parts per million
repro = reproductive
terato = teratogenic
TWA = Time Weighted Average (8-hour)

TABLE 1
SUMMARY OF THE CHEMICAL AND PHYSICAL HAZARDS
ASSOCIATED WITH EACH TASK

VAPOR INTRUSION INVESTIGATION IMPLEMENTATION
Santa Clara, California

A. CHEMICAL HAZARDS OF CONCERN

Contaminant	Monitoring Device	Action Level	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
Volatile Organic Compounds	PID	1000 ppb	Groundwater, Soil Vapor	Inh, Abs, Ing, Con	Irrit eyes, skin, nose; resp sys; gidd; head, nau,staggered gait; ftg, anor, lass; derm; bone marrow depres; [carc]	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Respiratory support Swallow: Medical attn. immediately.

TABLE 1
SUMMARY OF THE CHEMICAL AND PHYSICAL HAZARDS
ASSOCIATED WITH EACH TASK

VAPOR INTRUSION INVESTIGATION IMPLEMENTATION
Santa Clara, California

B. PHYSICAL HAZARDS OF CONCERN

Hazard	Description	Control Measures	First Aid
Lacerations and abrasions	Many opportunities working with utility knife and other hand tools	Inspect equipment being used for sharp edges, wear proper PPE; follow safe work practices	Refer to NSC "Emergency First Aid Guide"
Biological	Exposure to insects (wasps or poisonous spiders) and stray animals (cats)	Notify your buddy if you are allergic to bee stings. Do not approach stray animals.	Refer to NSC "Emergency First Aid Guide"
Heat and Cold Stress	Exposure to heat or cold.	Wear appropriate clothing and dress in layers.	Refer to NSC "Emergency First Aid Guide"
Electrical	Exposure to hazardous energy sources.	Use utility locating services prior to initiating subsurface activities. Be aware of overhead utilities.	Refer to NSC "Emergency First Aid Guide"
Noise	Exposure to noise from moving equipment (i.e., drill rig)	Wear hearing protection when working near heavy equipment.	Refer to NSC "Emergency First Aid Guide"
Inhalation	Exposure to volatile organic compounds during sub-slab soil vapor sampling potentially exposes all workers to breathing potentially hazardous material	Follow air monitoring plan; have ready access to respirator	See "A" above.
Lifting	Improper lifting/carrying of equipment and materials causing strains.	Follow safe lifting and general material handling techniques	Refer to NSC "Emergency First Aid Guide"
Slips, trips, and falls	Any number of injuries could occur from slips, trips, and falls in carrying out these tasks, esp. working on uneven, slippery surfaces.	Good housekeeping at site, constant awareness and focus on the task.	Refer to NSC "Emergency First Aid Guide"

TABLE 2
Summary of Monitoring Equipment

VAPOR INTRUSION INVESTIGATION IMPLEMENTATION
Santa Clara, California

Instrument	Operation Parameters
Ultraviolet (UV) Photoionization Detector (PID) (i.e., Hnu)	**Hazard Monitored:** Many organic and some inorganic gases and vapors. **Application:** Detects total concentration of many organic and some inorganic gases and vapors. Some identification of compounds are possible if more than one probe is measured. **Detection Method:** Ionizes molecules using UV radiation; produces a current that is proportional to the number of ions. **General Care/Maintenance:** Recharge or replace battery. Regularly clean lamp window. Regularly clean and maintain the instrument and accessories. **Typical Operating Time:** 10 hours. 5 hours with strip chart recorder.

Table 3
Action Levels
Vapor Intrusion Investigation Implementation
Santa Clara, California

Chemical of Concern	OSHA PEL[1] (ppmv)	1/2 OSHA PEL (ppbv)	ppbRAE Plus (10.6eV) Correction Factor[2]	Alert Level (ppmv)	Alert Level (ppbv)
1,1,1-trichloroethane (1,1,1-TCA)	350	175	NR	--	--
1,1,2-trichloroethane	10	5	NR	--	--
1,1-dichloroethane (1,1-DCA)	100	50	--	--	--
1,1-dichloroethene (1,1-DCE)	--	--	0.82	--	--
1,2-dichlorobenzene	50	25	0.47	11.75	11750
1,2-dichloroethane	1.00	0.5	NR	--	--
1,4-dichlorobenzene	75	38	--	--	--
chlorobenzene	75	38	0.4	15	15000
chloroethane (ethyl chloride)	1000	500	NR	--	--
chloroform	50	25	NR	--	--
cis-1,2-dichloroethene (cis-1,2-DCE)	--	--	--	--	--
dichloromethane (methylene chloride)	25	13	NR	--	--
tetrachloroethene (PCE)	100	50	0.57	28.5	28500
trans-1,2-dichloroethene	--	--	0.45	--	--
trichloroethene (TCE)	100	50	0.54	27	27000
trichlorofluoromethane (Freon 11)	1000	500	--	--	--
trichlorotrifluoroethane (Freon 113)	1000	500	--	--	--
vinyl chloride	1.00	1	2	**1**	**1000**
ethylbenzene	100	50	0.52	26	26000
xylenes, total	100	50	0.46	23	23000
toluene	200	100	0.5	50	50000

Notes:

1. OSHA PELs were selected from the CDC's NIOSH Pocket Guide dated September 2007 (Available Online at: <http://www.cdc.gov/niosh/npg/>)
2. Correction factors for the ppbRAE Plus (10.6 eV) PID were selected from RAE Systems' Technical Note TN-106

BOLD = Site-specific action level

CDC = Centers for Disease Control and Prevention
NIOSH = National Institute for Occupational Safety and Health
OSHA = Occupational Safety & Health Administration
PEL = Permissible Exposure Limit

TABLE 4
EMERGENCY NOTIFICATION LIST

VAPOR INTRUSION INVESTIGATION IMPLEMENTATION
Santa Clara, California

(Must Be Posted)

ORGANIZATION	CONTACT	TELEPHONE
Santa Clara City Police Dept.	--	911 or 408-615-4700
Fire & Ambulance	--	911 or 408-378-4010
Kaiser Permanente	--	911 or 408-236-6400
Langan Project Manager (PM)	Joshua Graber	415-955-5286 415-254-8774
Langan Health & Safety Officer (HSO)	Mukta Patil	415-955-5241 858-336-0019
Langan Health & Safety Coordinator (HSC)	Anthony Moffa	215-491-6545
Langan Incident/Injury Hotline	Langan	210-398-4699
Texas Instruments	Emergency Response Team	1-6000
National Response Center (NRC)	--	800-424-8802
Chemtrec	--	800-424-9300
Center for Disease Control	--	404-488-4100
EPA (RCRA Superfund Hotline)	--	800-424-9346
TSCA Hotline	--	202-554-1404
National Poison Control Center	--	800-222-1222

TABLE 5
STANDING ORDERS

VAPOR INTRUSION INVESTIGATION IMPLEMENTATION
Santa Clara, California

(Must Be Posted)

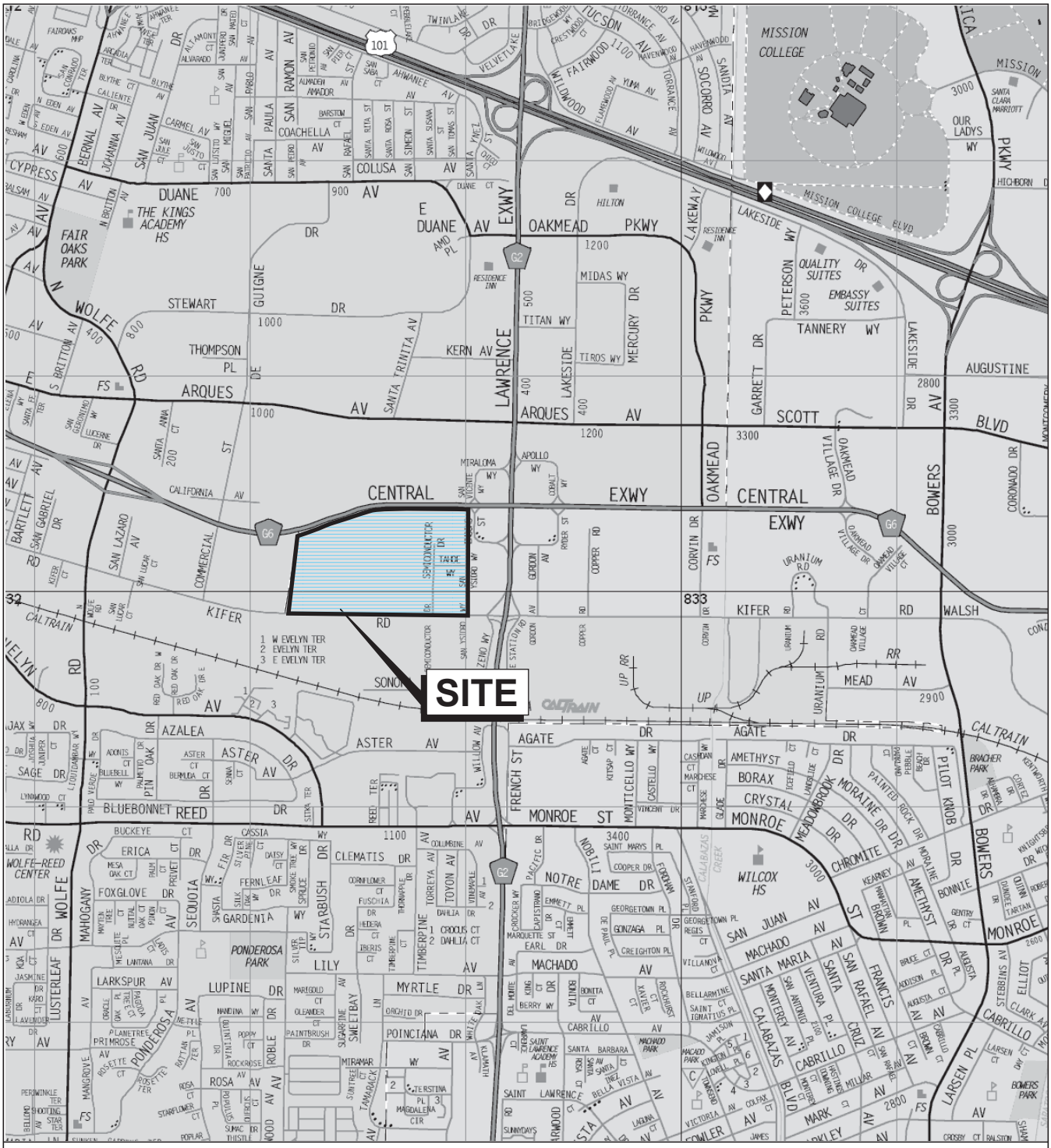
GENERAL

- No smoking, eating, or drinking in this work zone.
- Upon leaving the work zone, personnel will thoroughly wash their hands and face.
- Minimize contact with contaminated materials through proper planning of work areas and decontamination areas, and by following proper procedures. Do not place equipment on the ground.
- No open flames in the work zone.
- Only properly trained and equipped personnel are permitted to work in potentially contaminated areas.
- Always use the appropriate level of personal protective equipment (PPE).
- Maintain close contact with your buddy in the work zone
- Contaminated material will be contained in the Exclusion Zone (EZ).
- Report any unusual conditions.
- Work areas will be kept clear and uncluttered. Debris and other slip, trip, and fall hazards will be removed as frequently as possible.
- The number of personnel and equipment in the work zone will be kept to an essential minimum.
- Be alert to the symptoms of fatigue and heat/cold stress, and their effects on the normal caution and judgment of personnel.
- Conflicting situations which may arise concerning safety requirements and working conditions must be addressed and resolved quickly by the site HSO.

TOOLS AND HEAVY EQUIPMENT

- Do not, under any circumstances, enter or ride in or on any backhoe bucket, materials hoist, or any other device not specifically designed to carrying passengers.
- No open blades are allowed on site under any circumstances. Scissors or safety cutters must be used instead.
- Loose-fitting clothing or loose long hair is prohibited around moving machinery.
- Ensure that heavy equipment operators and all other personnel in the work zone are using the same hand signals to communicate.
- Drilling/excavating within 20 feet in any direction of overhead power lines is prohibited.
- The locations of all underground utilities must be identified and marked out prior to initiating any subsurface activities.
- Check to insure that the equipment operator has lowered all blades and buckets to the ground before shutting off the vehicle.
- If the equipment has an emergency stop device, have the operator show all personnel its location and how to activate it.
- Help the operator ensure adequate clearances when the equipment must negotiate in tight quarters; serve as a signalman to direct backing as necessary.
- Ensure that all heavy equipment that is used in the Exclusion Zone is kept in that zone until the job is done, and that such equipment is completely decontaminated before moving it into the clean area of the work zone.
- Samplers must not reach into or get near rotating equipment such as the drill rig. If personnel must work near any tools that could rotate, the equipment operator must completely shut down the rig prior to initiating such work. It may be necessary to use a remote sampling device.

FIGURES



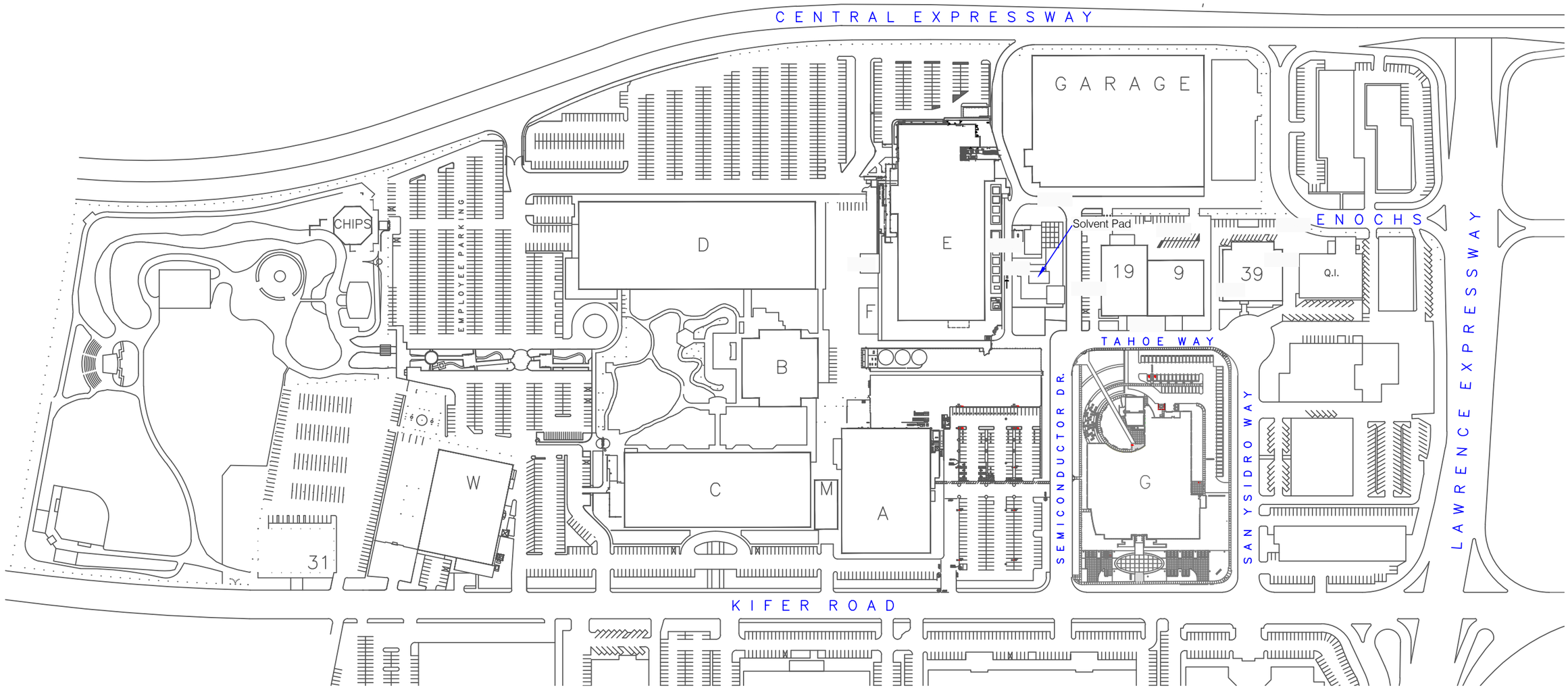
Base map: The Thomas Guide
Santa Clara County
1999

TEXAS INSTRUMENTS
BUILDING C
Santa Clara, California

Treadwell&Rollo
A LANGAN COMPANY

SITE LO□ATION MA□

Date 10/18/12	Project No. 730377986	Figure 1



N

0 240 Feet

Approximate scale

Source: "NSC Building Site Parking Spaces" - 6 January 2003, National Semiconductor Co.

TEXAS INSTRUMENTS
Santa Clara, California

SITE LAYOUT

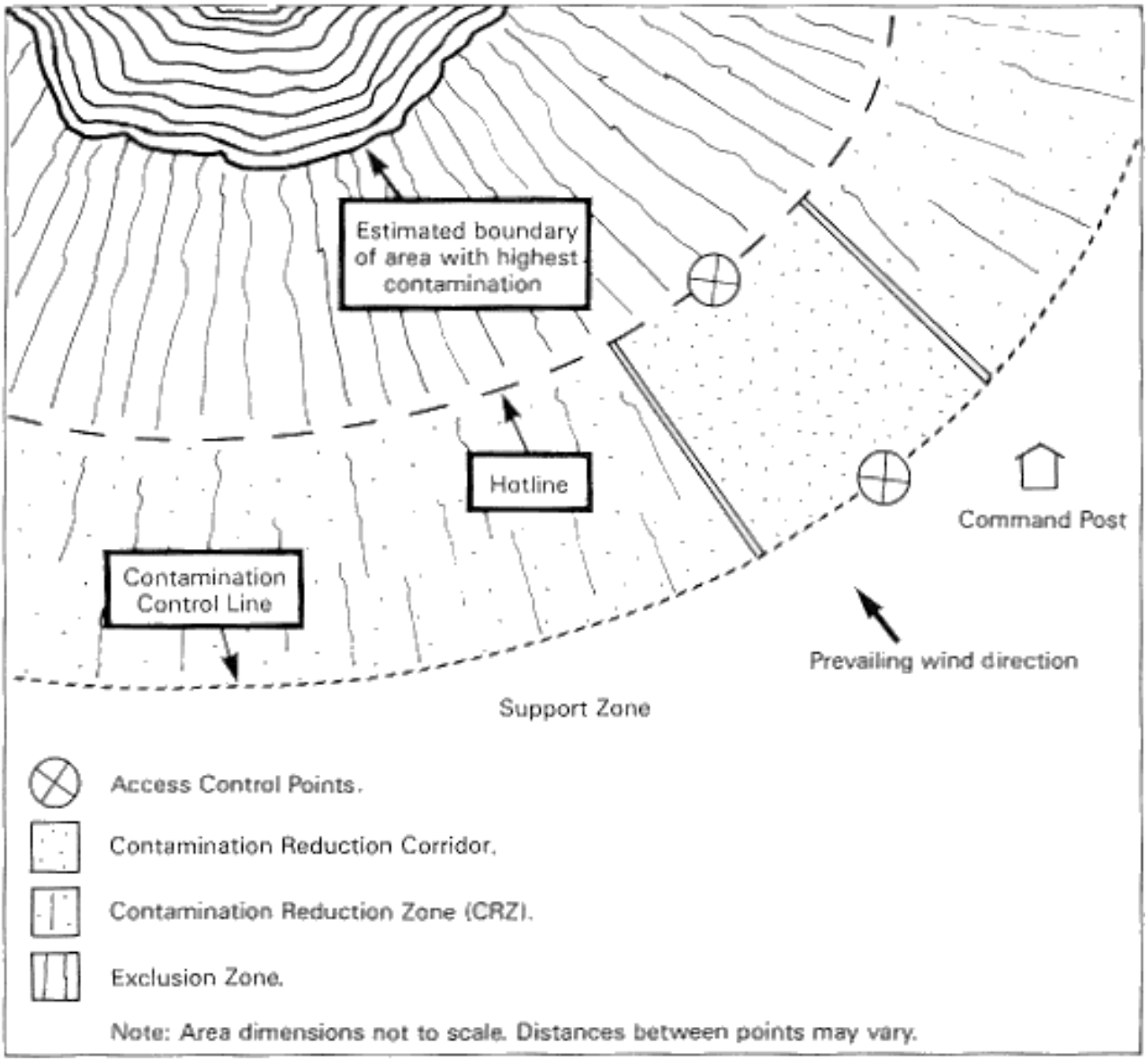
Date 10/18/12	Project No. 730377986	Figure 2

Treadwell&Rollo
A LANGAN COMPANY

\\langan.com\data\SF\data9\730377986\Cadd Data - 730377986\2D-DesignFiles\Environmental\730377986-Site Layout.dwg 10/18/12

FIGURE 3

GENERIC MAP OF SITE WORK ZONES



Map Source: NIOSH/OSHA/USCG/EPA "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities", October 1985.

Notes:

1. This is not a site-specific map, but a conceptual map depicting a typical layout of work zones at a generic hazardous waste site.

2. See the following text for descriptions of the work zones delineated on the map.

Delineation of Work Zones

Work zones are used to prevent or reduce the migration of contamination. The three recommended contiguous zones are provided below.

- Zone 1: Exclusion Zone
- Zone 2: Contamination Reduction Zone
- Zone 3: Support Zone

Less stringent site control and decontamination procedures may be used if more definitive information is available on the types of substances involved, their locations, and the hazards they present.

Zone 1: Exclusion Zone

The Exclusion Zone is the zone where contamination may exist. An entry and exit checkpoint must be established at the periphery of the Exclusion Zone to regulate the flow of personnel and equipment into and out of the zone.

The outer boundary of this zone, the Hotline, is initially established by visually surveying the area and determining where hazardous substances, drainage, leachate, or spilled material may be located, and whether any discolorations are visible, or from data from the initial site survey.

Additional factors that should be considered include:

- The distances needed to prevent fire or an explosion from affecting personnel outside the zone;
- The physical area necessary to conduct site operations; and,
- The potential for contaminants to be blown from the area.

The Hotline must be physically marked or fenced. The boundary may be modified and adjusted as more information becomes available.

All personnel within the Exclusion Zone must wear the required level of personal protective equipment established in the Health & Safety Plan.

Zone 2: Contamination Reduction Zone

The Contamination Reduction Zone is located between the Exclusion Zone and the Support Zone and provides a transition between contaminated and clean zones. It serves as a buffer to reduce the probability of the clean zone becoming contaminated. Within the Contamination Reduction Zone lies the Contamination Reduction Corridor. This corridor begins at the boundary of the Exclusion Zone and is the area where the decontamination stations are established. Exit from the Exclusion Zone must always be through a decontamination station.

The size and location of the Contamination Reduction Corridor depends on the wind direction (up or side wind), the number of stations in the decontamination procedure, the overall

dimension of work control zones, and the amount of space available at the site. An area of 75 by 15 feet should be adequate for most corridors.

Personnel in the Contamination Reduction Corridor must wear the personal protective equipment designated for the decontamination crew. Another corridor may be required for the entrance and exit of heavy equipment needing decontamination.

Access to the Contamination Reduction Corridor should be limited to personnel wearing the appropriate protection and activities should be limited to decontamination.

Factors to consider when organizing the Contamination Reduction Corridor and selecting decontaminants include:

- The extent and type of hazard expected;
- Explosive potential;
- Meteorological conditions;
- Topography;
- Levels of protection; and
- Availability of equipment and supplies.

Zone 3: Support Zone

The Support Zone is considered to be a non-contaminated or clean area. Support equipment (command post, equipment trailer, etc.) shall be located in the zone and traffic shall be restricted to authorized response personnel. Normal work clothes are appropriate within this zone; potentially contaminated personnel clothing, equipment, and samples must be left in the Contamination Reduction Zone until they are decontaminated.

The location of the command post and other support facilities in the Support Zone depends on the factors below.

1. Accessibility - The topography, available open space, and the locations of highways and railroad tracks.

2. Wind Direction - The support facilities shall be located upwind of the Exclusion Zone. Shifts in wind direction and other conditions may be such that an ideal location determined on the basis of wind direction alone does not exist.

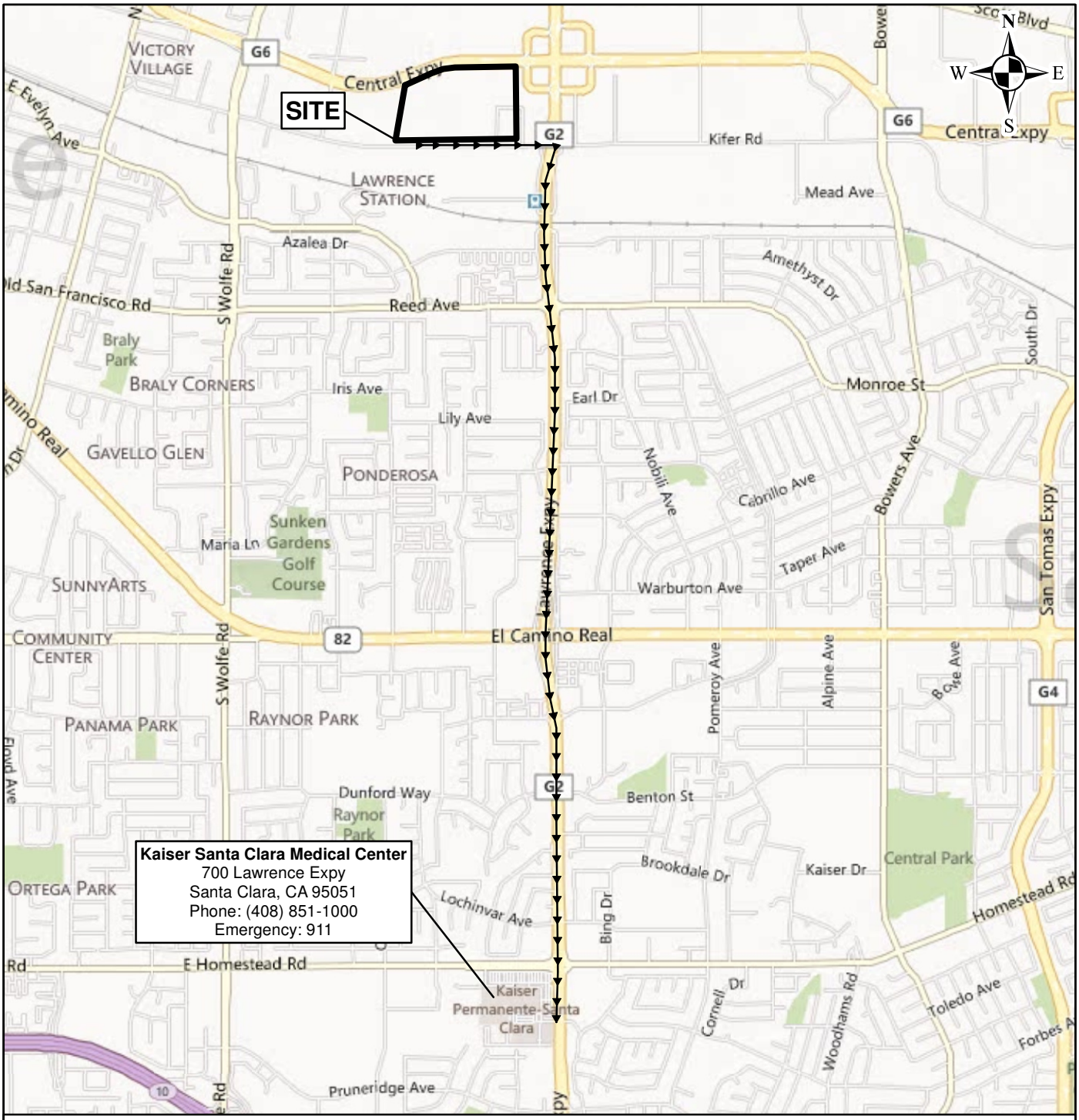
3. Resources - There should be adequate roads, power lines, water, and shelter.

Area Dimensions

The distance, size and shape of each zone must be based on conditions specific to each site. Distances between zone boundaries should be sufficient to allow room for the necessary operations, provide adequate distances to prevent the spread of contaminants, and eliminate the possibility of injury due to explosion or fire. Long-term operations should involve developing reasonable methods to determine if material is being transferred between zones and to assist in modifying site boundaries.

The following criteria shall be considered in establishing area dimensions and boundary distances:

1. Physical and topographical features of the site;
2. Weather conditions;
3. Field/laboratory measurements of air contaminants and environmental samples;
4. Air dispersion calculations;
5. Potential for explosion and flying debris;
6. Physical, chemical, toxicological, and other characteristics of the substances present;
7. Cleanup activities required;
8. Potential for fire;
9. Area needed to conduct operations;
10. Decontamination procedures;
11. Dimensions of contaminated area; and,
12. Potential for exposure.



Hospital Directions:

- Head south on Semiconductor Dr toward Kifer Rd, 0.1 mi
- Turn left onto Kifer Rd, 0.2 mi
- Turn right onto County Route G2/Lawrence Expy

Destination will be on the right, 2.7 mi

Total 2.9 mi (about 6 minutes)

700 Lawrence Expy, Santa Clara, California 95051

0 1,500 3,000 6,000

Feet

Map Source:

Bing Maps Hybrid aerial and roads basemap is provided throughLangan's ArcGIS online © 2010 Microsoft Corporation and its data suppliers.

NATIONAL SEMICONDUCTOR CORPORATION
Santa Clara, California

HOSPITAL ROUTE MAP

Treadwell&Rollo
A LANGAN COMPANY

Date 10/18/2012	Project 730377986	Figure 4

\\langan.com\data\SF\data9\730377986\ArcGIS\ArcMap_Documents\Route to Hospital (Map & Directions).mxd

APPENDIX D1

JOBSITE SAFETY INSPECTION CHECKLIST

JOBSITE SAFETY INSPECTION CHECKLIST

Client: _____ Inspection Date: _____

Site: _____ Inspector: _____

Project Number: _____

Check one of the following: **A:** Acceptable **NA**: Not Applicable **D**: Deficiency

	A	NA	D	Remarks
1. HASP available on site for inspection?				
2. Health & Safety Compliance agreement (in HASP) appropriately signed by Langan employees and subcontractors?				
3. Hospital route map with directions posted on site?				
4. Emergency Notification List posted on site?				
5. First Aid kit available and properly stocked?				
6. Personnel trained in CPR/First Aid on site?				
7. MSDSs readily available, and all workers knowledgeable about the specific chemicals and compounds to which they may be exposed?				
8 Appropriate PPE being worn by Langan employees and subcontractors?				
9. Project site safe practices ("Standing Orders") posted?				
10. Project staff have 40-hr./8-hr./Supervisor HAZWOPER training?				
11. Project staff medically cleared to work in hazardous waste sites and fit-tested to wear respirators, if needed?				
12. Respiratory protection readily available?				
13. Health & Safety Incident Report forms available?				
14. Air monitoring instruments calibrated daily and results recorded on the Daily Instrument Calibration check sheet?				
15. Air monitoring readings recorded on the air monitoring data sheet/field log book?				
16. Subcontract workers have received 40-hr./8-hr./Spvsr. HAZWOPER training, as appropriate?				
17. Subcontract workers medically cleared to work on site, and fit-tested for respirator wear?				
18. Subcontract workers have respirators readily available?				
19. Markouts of underground utilities done prior to initiating any subsurface activities?				
20. Decontamination procedures being followed as outlined in HASP?				
21. Are tools in good condition and properly used?				
22. Drilling performed in areas free from underground objects including utilities?				
23. Adequate size/type fire extinguisher supplied?				
24. Equipment at least 20 feet from overhead powerlines?				
25. Evidence that drilling operator is responsible for the safety of his rig.				
26. Trench sides shored, layed back, or boxed?				
27. Underground utilities located and authorities contacted before digging?				
28. Ladders in trench (25-foot spacing)?				
29. Excavated material placed more than 2 feet away from excavation edge?				
30. Public protected from exposure to open excavation?				

	A	NA	D	Remarks
31. People entering the excavation regarding it as a permit-required confined space and following appropriate procedures?				
32. Confined space entry permit is completed and posted?				
33. All persons knowledgable about the conditions and characteristics of the confined space?				
34. All persons engaged in confined space operations have been trained in safe entry and rescue (non-entry)?				
35. Full body harnesses, lifelines, and hoisting apparatus available for rescue needs?				
36. Attendant and/or supervisor certified in basic first aid and CPR?				
37. Confined space atmosphere checked before entry and continuously while the work is going on?				
38. Results of confined space atmosphere testing recorded?				
39. Evidence of coordination with off-site rescue services to perform entry rescue, if needed?				
40. Are extension cords rated for this work being used and are they properly maintained?				
41. Are GFCIs provided and being used?				

Unsafe acts observed? _____
_____
_____
_____

Additional remarks _____
_____
_____
_____

Distribution: Project Manager (for information and follow-up) Name: _____
Health & Safety Officer (for corrective action) Name: _____
Health & Safety Coordinator (resource for corrective action and follow-up)

Q:\Other\HealthandSafety\GenericAppendixAJobsiteSafetyInspectionChecklist RCB:03/21/01

APPENDIX D2

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS

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Methyl chloroform

Synonyms & Trade Names Chlorothene; 1,1,1-Trichloroethane; 1,1,1-Trichloroethane (stabilized)

CAS No. 71-55-6	**RTECS No.** KJ2975000 (/niosh-rtecs/KJ2D6518.html)	**DOT ID & Guide** 2831 160 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=160) (http://www.cdc.gov/Other/disclaimer.html)
Formula CH_3CCl_3	**Conversion** 1 ppm = 5.46 mg/m3	**IDLH** 700 ppm See: 71556 (/niosh/idlh/71556.html)
Exposure Limits **NIOSH REL** : C 350 ppm (1900 mg/m3) [15-minute] See Appendix C (nengapdxc.html) (Chloroethanes) **OSHA PEL** † (nengapdxg.html) : TWA 350 ppm (1900 mg/m3)		**Measurement Methods** **NIOSH** 1003 (/niosh/docs/2003-154/pdfs/1003.pdf) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with a mild, chloroform-like odor.

MW: 133.4	**BP:** 165° F	**FRZ:** -23°F	**Sol:** 0.4%	**VP:** 100 mmHg	**IP:** 11.00 eV
Sp.Gr: 1.34	**Fl.P:** ?	**UEL:** 12.5%	**LEL:** 7.5%		

Combustible Liquid, but burns with difficulty.

Incompatibilities & Reactivities Strong caustics; strong oxidizers; chemically-active metals such as zinc, aluminum, magnesium powders, sodium & potassium; water [Note: Reacts slowly with water to form hydrochloric acid.]

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin; headache, lassitude (weakness, exhaustion), central nervous system depression, poor equilibrium; dermatitis; cardiac arrhythmias; liver damage

Target Organs Eyes, skin, central nervous system, cardiovascular system, liver

Personal Protection/Sanitation (See protection codes (protect.html))	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately

Skin: Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet or contaminated **Change:** No recommendation	**Skin:** Soap wash promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations

NIOSH/OSHA

Up to 700 ppm:
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0079 (/niosh/ipcsneng/neng0079.html) See MEDICAL TESTS: 0141 (/niosh/docs/2005-110/nmed0141.html)

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1,1,2-Trichloroethane

Synonyms & Trade Names Ethane trichloride, β-Trichloroethane, Vinyl trichloride

CAS No. 79-00-5	**RTECS No.** KJ3150000 (/niosh-rtecs/KJ3010B0.html)	**DOT ID & Guide**
Formula $CHCl_2CH_2Cl$	**Conversion** 1 ppm = 5.46 mg/m³	**IDLH** Ca [100 ppm] See: 79005 (/niosh/idlh/79005.html)
Exposure Limits **NIOSH REL** : Ca TWA 10 ppm (45 mg/m³) [skin] See Appendix A (nengapdxa.html) See Appendix C (nengapdxc.html) (Chloroethanes) **OSHA PEL** : TWA 10 ppm (45 mg/m³) [skin]		**Measurement Methods** **NIOSH** 1003 (/niosh/docs/2003-154/pdfs/1003.pdf) ; **OSHA** 11 (http://www.osha.gov/dts/sltc/methods/organic/org011/org011.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with a sweet, chloroform-like odor.

MW: 133.4	**BP:** 237° F	**FRZ:** -34°F	**Sol:** 0.4%	**VP:** 19 mmHg	**IP:** 11.00 eV
Sp.Gr: 1.44	**Fl.P:** ?	**UEL:** 15.5%	**LEL:** 6%		

Combustible Liquid, forms dense soot.

Incompatibilities & Reactivities Strong oxidizers & caustics; chemically-active metals (such as aluminum, magnesium powders, sodium & potassium)

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, nose; central nervous system depression; liver, kidney damage; dermatitis; [potential occupational carcinogen]

Target Organs Eyes, respiratory system, central nervous system, liver, kidneys

Cancer Site [in animals: liver cancer]

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet or contaminated **Change:** No recommendation **Provide:** Eyewash, Quick drench	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0080 (/niosh/ipcsneng/neng0080.html)
See MEDICAL TESTS: 0235 (/niosh/docs/2005-110/nmed0235.html)

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1,1-Dichloroethane

Synonyms & Trade Names Asymmetrical dichloroethane; Ethylidene chloride; 1,1-Ethylidene dichloride

CAS No. 75-34-3	**RTECS No.** KI0175000 (/niosh-rtecs/KI2AB98.html)	**DOT ID & Guide** 2362 130 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=130) (http://www.cdc.gov/Other/disclaimer.html)
Formula $CHCl_2CH_3$	**Conversion** 1 ppm = 4.05 mg/m³	**IDLH** 3000 ppm See: 75343 (/niosh/idlh/75343.html)
Exposure Limits **NIOSH REL** : TWA 100 ppm (400 mg/m³) See Appendix C (nengapdxc.html) (Chloroethanes) **OSHA PEL** : TWA 100 ppm (400 mg/m³)		**Measurement Methods** **NIOSH** 1003 (/niosh/docs/2003-154/pdfs/1003.pdf) ; **OSHA** 7 (http://www.osha.gov/dts/sltc/methods/organic/org001/org001.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless, oily liquid with a chloroform-like odor.

MW: 99.0	**BP:** 135° F	**FRZ:** -143° F	**Sol:** 0.6%	**VP:** 182 mmHg	**IP:** 11.06 eV
Sp.Gr: 1.18	**Fl.P:** 2° F	**UEL:** 11.4%	**LEL:** 5.4%		

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

Incompatibilities & Reactivities Strong oxidizers, strong caustics

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms irritation skin; central nervous system depression; liver, kidney, lung damage

Target Organs Skin, liver, kidneys, lungs, central nervous system

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet (flammable) **Change:** No recommendation	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap flush promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations
NIOSH/OSHA

Up to 1000 ppm:
(APF = 10) Any supplied-air respirator

Up to 2500 ppm:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode

Up to 3000 ppm:
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0249 (/niosh/ipcsneng/neng0249.html)

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Vinylidene chloride

Synonyms & Trade Names 1,1-DCE; 1,1-Dichloroethene; 1,1-Dichloroethylene; VDC; Vinylidene chloride monomer; Vinylidene dichloride

CAS No. 75-35-4	**RTECS No.** KV9275000 (/niosh-rtecs/KV8D8678.html)	**DOT ID & Guide** 1303 130P (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=130&poly=1) (http://www.cdc.gov/Other/disclaimer.html) (inhibited)
Formula $CH_2=CCl_2$	**Conversion**	**IDLH** Ca [N.D.] See: IDLH INDEX (/niosh/idlh/intridl4.html)
Exposure Limits **NIOSH REL** : Ca See Appendix A (nengapdxa.html) **OSHA PEL** † (nengapdxg.html) : none		**Measurement Methods** **NIOSH** 1015 (/niosh/docs/2003-154/pdfs/1015.pdf) ; **OSHA** 19 (http://www.osha.gov/dts/sltc/methods/organic/org019/org019.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid or gas (above 89°F) with a mild, sweet, chloroform-like odor.

MW: 96.9	**BP:** 89° F	**FRZ:** -189° F	**Sol:** 0.04%	**VP:** 500 mmHg	**IP:** 10.00 eV
Sp.Gr: 1.21	**Fl.P:** -2°F	**UEL:** 15.5%	**LEL:** 6.5%		

Class IA Flammable Liquid: Fl.P. below 73°F and BP below 100°F.

Incompatibilities & Reactivities Aluminum, sunlight, air, copper, heat [Note: Polymerization may occur if exposed to oxidizers, chlorosulfonic acid, nitric acid, or oleum. Inhibitors such as the monomethyl ether of hydroquinone are added to prevent polymerization.]

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin, throat; dizziness, headache, nausea, dyspnea (breathing difficulty); liver, kidney disturbance; pneumonitis; [potential occupational carcinogen]

Target Organs Eyes, skin, respiratory system, central nervous system, liver, kidneys

Cancer Site [in animals: liver & kidney tumors]

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet (flammable)	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap flush immediately **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Change: No recommendation
Provide: Eyewash, Quick drench

Respirator Recommendations

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0083 (/niosh/ipcsneng/neng0083.html)

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Vinylidene chloride

Synonyms & Trade Names 1,1-DCE; 1,1-Dichloroethene; 1,1-Dichloroethylene; VDC; Vinylidene chloride monomer; Vinylidene dichloride

CAS No. 75-35-4	**RTECS No.** KV9275000 (/niosh-rtecs/KV8D8678.html)	**DOT ID & Guide** 1303 130P (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=130&poly=1) (http://www.cdc.gov/Other/disclaimer.html) (inhibited)
Formula $CH_2=CCl_2$	**Conversion**	**IDLH** Ca [N.D.] See: IDLH INDEX (/niosh/idlh/intridl4.html)
Exposure Limits **NIOSH REL** : Ca See Appendix A (nengapdxa.html) **OSHA PEL** † (nengapdxg.html) : none		**Measurement Methods** **NIOSH** 1015 (/niosh/docs/2003-154/pdfs/1015.pdf) ; **OSHA** 19 (http://www.osha.gov/dts/sltc/methods/organic/org019/org019.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid or gas (above 89°F) with a mild, sweet, chloroform-like odor.

MW: 96.9	**BP:** 89° F	**FRZ:** -189° F	**Sol:** 0.04%	**VP:** 500 mmHg	**IP:** 10.00 eV
Sp.Gr: 1.21	**Fl.P:** -2°F	**UEL:** 15.5%	**LEL:** 6.5%		

Class IA Flammable Liquid: Fl.P. below 73°F and BP below 100°F.

Incompatibilities & Reactivities Aluminum, sunlight, air, copper, heat [Note: Polymerization may occur if exposed to oxidizers, chlorosulfonic acid, nitric acid, or oleum. Inhibitors such as the monomethyl ether of hydroquinone are added to prevent polymerization.]

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin, throat; dizziness, headache, nausea, dyspnea (breathing difficulty); liver, kidney disturbance; pneumonitis; [potential occupational carcinogen]

Target Organs Eyes, skin, respiratory system, central nervous system, liver, kidneys

Cancer Site [in animals: liver & kidney tumors]

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet (flammable)	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap flush immediately **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Change: No recommendation
Provide: Eyewash, Quick drench

Respirator Recommendations

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0083 (/niosh/ipcsneng/neng0083.html)

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o-Dichlorobenzene

Synonyms & Trade Names o-DCB; 1,2-Dichlorobenzene; ortho-Dichlorobenzene; o-Dichlorobenzol

CAS No. 95-50-1	**RTECS No.** CZ4500000 (/niosh-rtecs/CZ44AA20.html)	**DOT ID & Guide** 1591 152 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=152) (http://www.cdc.gov/Other/disclaimer.html)
Formula $C_6H_4Cl_2$	**Conversion** 1 ppm = 6.01 mg/m³	**IDLH** 200 ppm See: 95501 (/niosh/idlh/95501.html)
Exposure Limits **NIOSH REL** : C 50 ppm (300 mg/m³) **OSHA PEL** : C 50 ppm (300 mg/m³)		**Measurement Methods** **NIOSH** 1003 (/niosh/docs/2003-154/pdfs/1003.pdf) ; **OSHA** 7 (http://www.osha.gov/dts/sltc/methods/organic/org001/org001.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless to pale-yellow liquid with a pleasant, aromatic odor. [herbicide]

MW: 147.0	**BP:** 357° F	**FRZ:** 1°F	**Sol:** 0.01%	**VP:** 1 mmHg	**IP:** 9.06 eV
Sp.Gr: 1.30	**Fl.P:** 151° F	**UEL:** 9.2%	**LEL:** 2.2%		

Class IIIA Combustible Liquid: Fl.P. at or above 140°F and below 200°F.

Incompatibilities & Reactivities Strong oxidizers, aluminum, chlorides, acids, acid fumes

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, nose; liver, kidney damage; skin blisters

Target Organs Eyes, skin, respiratory system, liver, kidneys

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet or contaminated **Change:** No recommendation	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations
NIOSH/OSHA

Up to 200 ppm:
(APF = 50) Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)

(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)[£]
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 1066 (/niosh/ipcsneng/neng1066.html)
See MEDICAL TESTS: 0255 (/niosh/docs/2005-110/nmed0255.html)

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Ethylene dichloride

Synonyms & Trade Names 1,2-Dichloroethane; Ethylene chloride; Glycol dichloride

CAS No. 107-06-2	**RTECS No.** KI0525000 (/niosh-rtecs/KI802C8.html)	**DOT ID & Guide** 1184 131 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=131) (http://www.cdc.gov/Other/disclaimer.html)
Formula $ClCH_2CH_2Cl$	**Conversion** 1 ppm = 4.05 mg/m³	**IDLH** Ca [50 ppm] See: 107062 (/niosh/idlh/107062.html)
Exposure Limits **NIOSH REL** : Ca TWA 1 ppm (4 mg/m³) ST 2 ppm (8 mg/m³) See Appendix A (nengapdxa.html) See Appendix C (nengapdxc.html) (Chloroethanes) **OSHA PEL** † (nengapdxg.html) : TWA 50 ppm C 100 ppm 200 ppm [5-minute maximum peak in any 3 hours]		**Measurement Methods** **NIOSH** 1003 (/niosh/docs/2003-154/pdfs/1003.pdf) ; **OSHA** 3 (http://www.osha.gov/dts/sltc/methods/organic/org003/org003.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with a pleasant, chloroform-like odor. [Note: Decomposes slowly, becomes acidic & darkens in color.]

MW: 99.0	**BP:** 182° F	**FRZ:** -32°F	**Sol:** 0.9%	**VP:** 64 mmHg	**IP:** 11.05 eV
Sp.Gr: 1.24	**Fl.P:** 56° F	**UEL:** 16%	**LEL:** 6.2%		

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

Incompatibilities & Reactivities Strong oxidizers & caustics; chemically-active metals such as magnesium or aluminum powder, sodium & potassium; liquid ammonia [Note: Decomposes to vinyl chloride & HCl above 1112°F.]

Exposure Routes inhalation, ingestion, skin absorption, skin and/or eye contact

Symptoms irritation eyes, corneal opacity; central nervous system depression; nausea, vomiting; dermatitis; liver, kidney, cardiovascular system damage; [potential occupational carcinogen]

Target Organs Eyes, skin, kidneys, liver, central nervous system, cardiovascular system

Cancer Site [in animals: forestomach, mammary gland & circulatory sys cancer]

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash promptly

Wash skin: When contaminated **Remove:** When wet (flammable) **Change:** No recommendation **Provide:** Eyewash, Quick drench	**Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0250 (/niosh/ipcsneng/neng0250.html)
See MEDICAL TESTS: 0104 (/niosh/docs/2005-110/nmed0104.html)

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p-Dichlorobenzene

Synonyms & Trade Names p-DCB; 1,4-Dichlorobenzene; para-Dichlorobenzene; Dichlorocide

CAS No. 106-46-7	**RTECS No.** CZ4550000 (/niosh-rtecs/CZ456D70.html)	**DOT ID & Guide**
Formula $C_6H_4Cl_2$	**Conversion** 1 ppm = 6.01 mg/m³	**IDLH** Ca [150 ppm] See: 106467 (/niosh/idlh/106467.html)
Exposure Limits **NIOSH REL** : Ca See Appendix A (nengapdxa.html) **OSHA PEL** † (nengapdxg.html) : TWA 75 ppm (450 mg/m³)		**Measurement Methods** **NIOSH** 1003 (/niosh/docs/2003-154/pdfs/1003.pdf) ; **OSHA** 7 (http://www.osha.gov/dts/sltc/methods/organic/org001/org001.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless or white crystalline solid with a mothball-like odor. [insecticide]

MW: 147.0	**BP:** 345° F	MLT: 128°F	**Sol:** 0.008%	**VP:** 1.3 mmHg	**IP:** 8.98 eV
Sp.Gr: 1.25	**Fl.P:** 150° F	**UEL:** ?	**LEL:** 2.5%		

Combustible Solid, but may take some effort to ignite.

Incompatibilities & Reactivities Strong oxidizers (such as chlorine or permanganate)

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms Eye irritation, swelling periorbital (situated around the eye); profuse rhinitis; headache, anorexia, nausea, vomiting; weight loss, jaundice, cirrhosis; in animals: liver, kidney injury; [potential occupational carcinogen]

Target Organs Liver, respiratory system, eyes, kidneys, skin

Cancer Site [in animals: liver & kidney cancer]

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated/Daily **Remove:** When wet or contaminated	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Change: Daily
Provide: Eyewash, Quick drench

Respirator Recommendations

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0037 (/niosh/ipcsneng/neng0037.html)
See MEDICAL TESTS: 0073 (/niosh/docs/2005-110/nmed0073.html)

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Chlorobenzene

Synonyms & Trade Names Benzene chloride, Chlorobenzol, MCB, Monochlorobenzene, Phenyl chloride

CAS No. 108-90-7	**RTECS No.** CZ0175000 (/niosh-rtecs/CZ2AB98.html)	**DOT ID & Guide** 1134 130 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=130) (http://www.cdc.gov/Other/disclaimer.html)
Formula C_6H_5Cl	**Conversion** 1 ppm = 4.61 mg/m³	**IDLH** 1000 ppm See: 108907 (/niosh/idlh/108907.html)
Exposure Limits **NIOSH REL** : See Appendix D (nengapdxd.html) **OSHA PEL** : TWA 75 ppm (350 mg/m³)		**Measurement Methods** **NIOSH** 1003 (/niosh/docs/2003-154/pdfs/1003.pdf) ; **OSHA** 7 (http://www.osha.gov/dts/sltc/methods/organic/org001/org001.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with an almond-like odor.

MW: 112.6	**BP:** 270° F	**FRZ:** -50° F	**Sol:** 0.05%	**VP:** 9 mmHg	**IP:** 9.07 eV
Sp.Gr: 1.11	**Fl.P:** 82° F	**UEL:** 9.6%	**LEL:** 1.3%		

Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F.

Incompatibilities & Reactivities Strong oxidizers

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin, nose; drowsiness, incoordination; central nervous system depression; in animals: liver, lung, kidney injury

Target Organs Eyes, skin, respiratory system, central nervous system, liver

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet (flammable) **Change:** No recommendation	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations
OSHA

Up to 1000 ppm:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode£
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)£
(APF = 50) Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0642 (/niosh/ipcsneng/neng0642.html)
See MEDICAL TESTS: 0253 (/niosh/docs/2005-110/nmed0253.html)

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Chloroform

Synonyms & Trade Names Methane trichloride, Trichloromethane

CAS No. 67-66-3	**RTECS No.** FS9100000 (/niosh-rtecs/FS8ADAE0.html)	**DOT ID & Guide** 1888 151 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=151) (http://www.cdc.gov/Other/disclaimer.html)
Formula $CHCl_3$	**Conversion** 1 ppm = 4.88 mg/m3	**IDLH** Ca [500 ppm] See: 67663 (/niosh/idlh/67663.html)
Exposure Limits **NIOSH REL** : Ca ST 2 ppm (9.78 mg/m3) [60-minute] See Appendix A (nengapdxa.html) **OSHA PEL** † (nengapdxg.html) : C 50 ppm (240 mg/m3)		**Measurement Methods** **NIOSH** 1003 (/niosh/docs/2003-154/pdfs/1003.pdf) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with a pleasant odor.

MW: 119.4	**BP:** 143° F	**FRZ:** -82° F	Sol(77° F): 0.5%	**VP:** 160 mmHg	**IP:** 11.42 eV
Sp.Gr: 1.48	**Fl.P:** NA	**UEL:** NA	**LEL:** NA		

Noncombustible Liquid

Incompatibilities & Reactivities Strong caustics; chemically-active metals such as aluminum or magnesium powder, sodium & potassium; strong oxidizers [Note: When heated to decomposition, forms phosgene gas.]

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin; dizziness, mental dullness, nausea, confusion; headache, lassitude (weakness, exhaustion); anesthesia; enlarged liver; [potential occupational carcinogen]

Target Organs Liver, kidneys, heart, eyes, skin, central nervous system

Cancer Site [in animals: liver & kidney cancer]

Personal Protection/Sanitation (See protection codes (protect.html))
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: No recommendation
Provide: Eyewash, Quick drench

First Aid (See procedures (firstaid.html))
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0027 (/niosh/ipcsneng/neng0027.html) See MEDICAL TESTS: 0047 (/niosh/docs/2005-110/nmed0047.html)

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Ethyl chloride

Synonyms & Trade Names Chloroethane, Hydrochloric ether, Monochloroethane, Muriatic ether

CAS No. 75-00-3	**RTECS No.** KH7525000 (/niosh-rtecs/KH72D288.html)	**DOT ID & Guide** 1037 115 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=115) (http://www.cdc.gov/Other/disclaimer.html)
Formula CH_3CH_2Cl	**Conversion** 1 ppm = 2.64 mg/m³	**IDLH** 3800 ppm [10%LEL] See: 75003 (/niosh/idlh/75003.html)
Exposure Limits **NIOSH REL** : Handle with caution in the workplace. See Appendix C (nengapdxc.html) (Chloroethanes) **OSHA PEL** : TWA 1000 ppm (2600 mg/m³)		**Measurement Methods** **NIOSH** 2519 (/niosh/docs/2003-154/pdfs/2519.pdf) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless gas or liquid (below 54°F) with a pungent, ether-like odor. [Note: Shipped as a liquefied compressed gas.]

MW: 64.5	**BP:** 54° F	**FRZ:** -218° F	**Sol:** 0.6%	**VP:** 1000 mmHg	**IP:** 10.97 eV
Sp.Gr: 0.92 (Liquid at 32°F)	**Fl.P:** NA (Gas) - 58°F (Liquid)	**UEL:** 15.4%	**LEL:** 3.8%	**RGasD:** 2.23	

Flammable Gas

Incompatibilities & Reactivities Chemically-active metals such as sodium, potassium, calcium, powdered aluminum, zinc & magnesium; oxidizers; water or steam [Note: Reacts with water to form hydrochloric acid.]

Exposure Routes inhalation, skin absorption (liquid), ingestion (liquid), skin and/or eye contact

Symptoms incoordination, inebriation; abdominal cramps; cardiac arrhythmias, cardiac arrest; liver, kidney damage

Target Organs Liver, kidneys, respiratory system, cardiovascular system, central nervous system

Personal Protection/Sanitation (See protection codes (protect.html))
Skin: Prevent skin contact (liquid)
Eyes: Prevent eye contact (liquid)
Wash skin: No recommendation
Remove: When wet (flammable)
Change: No recommendation

First Aid (See procedures (firstaid.html))
Eye: Irrigate immediately (liquid)
Skin: Water flush promptly (liquid)
Breathing: Respiratory support
Swallow: Medical attention immediately (liquid)

Respirator Recommendations
OSHA

Up to 3800 ppm:
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0132 (/niosh/ipcsneng/neng0132.html)

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Ethyl benzene

Synonyms & Trade Names Ethylbenzol, Phenylethane

CAS No. 100-41-4	**RTECS No.** DA0700000 (/niosh-rtecs/DAAAE60.html)	**DOT ID & Guide** 1175 130 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=130) (http://www.cdc.gov/Other/disclaimer.html)
Formula $CH_3CH_2C_6H_5$	**Conversion** 1 ppm = 4.34 mg/m³	**IDLH** 800 ppm [10%LEL] See: 100414 (/niosh/idlh/100414.html)
Exposure Limits **NIOSH REL** : TWA 100 ppm (435 mg/m³) ST 125 ppm (545 mg/m³) **OSHA PEL** † (nengapdxg.html) : TWA 100 ppm (435 mg/m³)		**Measurement Methods** **NIOSH** 1501 (/niosh/docs/2003-154/pdfs/1501.pdf) ; **OSHA** 7 (http://www.osha.gov/dts/sltc/methods/organic/org001/org001.html) (http://www.cdc.gov/Other/disclaimer.html) , 1002 (http://www.osha.gov/dts/sltc/methods/mdt/mdt1002/1002.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with an aromatic odor.

MW: 106.2	**BP:** 277° F	**FRZ:** -139°F	**Sol:** 0.01%	**VP:** 7 mmHg	**IP:** 8.76 eV
Sp.Gr: 0.87	**Fl.P:** 55° F	**UEL:** 6.7%	**LEL:** 0.8%		

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

Incompatibilities & Reactivities Strong oxidizers

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma

Target Organs Eyes, skin, respiratory system, central nervous system

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet (flammable) **Change:** No recommendation	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Water flush promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations
NIOSH/OSHA

Up to 800 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0268 (/niosh/ipcsneng/neng0268.html)
See MEDICAL TESTS: 0098 (/niosh/docs/2005-110/nmed0098.html)

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1,1,2-Trichloro-1,2,2-trifluoroethane

Synonyms & Trade Names Chlorofluorocarbon-113, CFC-113, Freon® 113, Genetron® 113, Halocarbon 113, Refrigerant 113, TTE

CAS No. 76-13-1	**RTECS No.** KJ4000000 (/niosh-rtecs/KJ3D0900.html)	**DOT ID & Guide**
Formula CCl_2FCClF_2	**Conversion** 1 ppm = 7.67 mg/m³	**IDLH** 2000 ppm See: 76131 (/niosh/idlh/76131.html)
Exposure Limits **NIOSH REL** : TWA 1000 ppm (7600 mg/m³) ST 1250 ppm (9500 mg/m³) **OSHA PEL** † (nengapdxg.html) : TWA 1000 ppm (7600 mg/m³)		**Measurement Methods** **NIOSH** 1020 (/niosh/docs/2003-154/pdfs/1020.pdf) ; **OSHA** 113 (http://www.osha.gov/dts/sltc/methods/organic/org113/org113.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless to water-white liquid with an odor like carbon tetrachloride at high concentrations. [Note: A gas above 118°F.]

MW: 187.4	**BP:** 118° F	**FRZ:** -31°F	Sol(77°F): 0.02%	**VP:** 285 mmHg	**IP:** 11.99 eV
Sp.Gr(77° F): 1.56	**Fl.P:** ?	**UEL:** ?	**LEL:** ?		

Noncombustible Liquid at ordinary temperatures, but the gas will ignite and burn weakly at 1256°F.

Incompatibilities & Reactivities Chemically-active metals such as calcium, powdered aluminum, zinc, magnesium & beryllium [Note: Decomposes if in contact with alloys containing >2% magnesium.]

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms irritation skin, throat, drowsiness, dermatitis; central nervous system depression; in animals: cardiac arrhythmias, narcosis

Target Organs Skin, heart, central nervous system, cardiovascular system

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Remove: When wet or contaminated
Change: No recommendation

Respirator Recommendations
NIOSH/OSHA

Up to 2000 ppm:
(APF = 10) Any supplied-air respirator
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure -demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0050 (/niosh/ipcsneng/neng0050.html)

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Methylene chloride

Synonyms & Trade Names Dichloromethane, Methylene dichloride

CAS No. 75-09-2	**RTECS No.** PA8050000 (/niosh-rtecs/PA7AD550.html)	**DOT ID & Guide** 1593 160 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=160) (http://www.cdc.gov/Other/disclaimer.html)
Formula CH_2Cl_2	**Conversion** 1 ppm = 3.47 mg/m3	**IDLH** Ca [2300 ppm] See: 75092 (/niosh/idlh/75092.html)
Exposure Limits **NIOSH REL** : Ca See Appendix A (nengapdxa.html) **OSHA PEL** : [1910.1052] TWA 25 ppm ST 125 ppm		**Measurement Methods** **NIOSH** 1005 (/niosh/docs/2003-154/pdfs/1005.pdf) , 3800 (/niosh/docs/2003-154/pdfs/3800.pdf) ; **OSHA** 59 (http://www.osha.gov/dts/sltc/methods/organic/org059/org059.html) (http://www.cdc.gov/Other/disclaimer.html) , 80 (http://www.osha.gov/dts/sltc/methods/organic/org080/org080.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with a chloroform-like odor. [Note: A gas above 104°F.]

MW: 84.9	**BP:** 104° F	**FRZ:** -139°F	**Sol:** 2%	**VP:** 350 mmHg	**IP:** 11.32 eV
Sp.Gr: 1.33	**Fl.P:** ?	**UEL:** 23%	**LEL:** 13%		

Combustible Liquid

Incompatibilities & Reactivities Strong oxidizers; caustics; chemically-active metals such as aluminum, magnesium powders, potassium & sodium; concentrated nitric acid

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin; lassitude (weakness, exhaustion), drowsiness, dizziness; numb, tingle limbs; nausea; [potential occupational carcinogen]

Target Organs Eyes, skin, cardiovascular system, central nervous system

Cancer Site [in animals: lung, liver, salivary & mammary gland tumors]

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet or contaminated	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Change: No recommendation
Provide: Eyewash, Quick drench

Respirator Recommendations
(See Appendix E) (nengapdxe.html)

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0058 (/niosh/ipcsneng/neng0058.html)
See MEDICAL TESTS: 0148 (/niosh/docs/2005-110/nmed0148.html)

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m-Xylene

Synonyms & Trade Names 1,3-Dimethylbenzene; meta-Xylene; m-Xylol

CAS No. 108-38-3	**RTECS No.** ZE2275000 (/niosh-rtecs/ZE22B6B8.html)	**DOT ID & Guide** 1307 130 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=130) (http://www.cdc.gov/Other/disclaimer.html)
Formula $C_6H_4(CH_3)_2$	**Conversion** 1 ppm = 4.34 mg/m³	**IDLH** 900 ppm See: 95476 (/niosh/idlh/95476.html)
Exposure Limits **NIOSH REL** : TWA 100 ppm (435 mg/m³) ST 150 ppm (655 mg/m³) **OSHA PEL** † (nengapdxg.html) : TWA 100 ppm (435 mg/m³)		**Measurement Methods** **NIOSH** 1501 (/niosh/docs/2003-154/pdfs/1501.pdf) , 3800 (/niosh/docs/2003-154/pdfs/3800.pdf) ; **OSHA** 1002 (http://www.osha.gov/dts/sltc/methods/mdt/mdt1002/1002.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with an aromatic odor.

MW: 106.2	**BP:** 282° F	**FRZ:** -54° F	**Sol:** Slight	**VP:** 9 mmHg	**IP:** 8.56 eV
Sp.Gr: 0.86	**Fl.P:** 82° F	**UEL:** 7.0%	**LEL:** 1.1%		

Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F.

Incompatibilities & Reactivities Strong oxidizers, strong acids

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis

Target Organs Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet (flammable) **Change:** No recommendation	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations

NIOSH/OSHA

Up to 900 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure -demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0085 (/niosh/ipcsneng/neng0085.html)

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o-Xylene

Synonyms & Trade Names 1,2-Dimethylbenzene; ortho-Xylene; o-Xylol

CAS No. 95-47-6	**RTECS No.** ZE2450000 (/niosh-rtecs/ZE256250.html)	**DOT ID & Guide** 1307 130 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=130) (http://www.cdc.gov/Other/disclaimer.html)
Formula $C_6H_4(CH_3)_2$	**Conversion** 1 ppm = 4.34 mg/m³	**IDLH** 900 ppm See: 95476 (/niosh/idlh/95476.html)
Exposure Limits **NIOSH REL** : TWA 100 ppm (435 mg/m³) ST 150 ppm (655 mg/m³) **OSHA PEL** † (nengapdxg.html) : TWA 100 ppm (435 mg/m³)		**Measurement Methods** **NIOSH** 1501 (/niosh/docs/2003-154/pdfs/1501.pdf) , 3800 (/niosh/docs/2003-154/pdfs/3800.pdf) ; **OSHA** 1002 (http://www.osha.gov/dts/sltc/methods/mdt/mdt1002/1002.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with an aromatic odor.

MW: 106.2	**BP:** 292° F	**FRZ:** -13° F	**Sol:** 0.02%	**VP:** 7 mmHg	**IP:** 8.56 eV
Sp.Gr: 0.88	**Fl.P:** 90° F	**UEL:** 6.7%	**LEL:** 0.9%		

Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F.

Incompatibilities & Reactivities Strong oxidizers, strong acids

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis

Target Organs Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet (flammable) **Change:** No recommendation	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations
NIOSH/OSHA

Up to 900 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0084 (/niosh/ipcsneng/neng0084.html)

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p-Xylene

Synonyms & Trade Names 1,4-Dimethylbenzene; para-Xylene; p-Xylol

CAS No. 106-42-3	**RTECS No.** ZE2625000 (/niosh-rtecs/ZE280DE8.html)	**DOT ID & Guide** 1307 130 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=130) (http://www.cdc.gov/Other/disclaimer.html)
Formula $C_6H_4(CH_3)_2$	**Conversion** 1 ppm = 4.41 mg/m³	**IDLH** 900 ppm See: 95476 (/niosh/idlh/95476.html)
Exposure Limits **NIOSH REL** : TWA 100 ppm (435 mg/m³) ST 150 ppm (655 mg/m³) **OSHA PEL** † (nengapdxg.html) : TWA 100 ppm (435 mg/m³)		**Measurement Methods** **NIOSH** 1501 (/niosh/docs/2003-154/pdfs/1501.pdf) , 3800 (/niosh/docs/2003-154/pdfs/3800.pdf) ; **OSHA** 1002 (http://www.osha.gov/dts/sltc/methods/mdt/mdt1002/1002.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with an aromatic odor. [Note: A solid below 56°F.]

MW: 106.2	**BP:** 281° F	**FRZ:** 56°F	**Sol:** 0.02%	**VP:** 9 mmHg	**IP:** 8.44 eV
Sp.Gr: 0.86	**Fl.P:** 81° F	**UEL:** 7.0%	**LEL:** 1.1%		

Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F.

Incompatibilities & Reactivities Strong oxidizers, strong acids

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis

Target Organs Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet (flammable) **Change:** No recommendation	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations

NIOSH/OSHA

Up to 900 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0086 (/niosh/ipcsneng/neng0086.html)

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Tetrachloroethylene

Synonyms & Trade Names Perchlorethylene, Perchloroethylene, Perk, Tetrachlorethylene

CAS No. 127-18-4	**RTECS No.** KX3850000 (/niosh-rtecs/KX3ABF10.html)	**DOT ID & Guide** 1897 160 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=160) (http://www.cdc.gov/Other/disclaimer.html)
Formula $Cl_2C=CCl_2$	**Conversion** 1 ppm = 6.78 mg/m3	**IDLH** Ca [150 ppm] See: 127184 (/niosh/idlh/127184.html)
Exposure Limits **NIOSH REL** : Ca Minimize workplace exposure concentrations. See Appendix A (nengapdxa.html) **OSHA PEL** † (nengapdxg.html) : TWA 100 ppm C 200 ppm (for 5 minutes in any 3-hour period), with a maximum peak of 300 ppm		**Measurement Methods** **NIOSH** 1003 (/niosh/docs/2003-154/pdfs/1003.pdf) ; **OSHA** 1001 (http://www.osha.gov/dts/sltc/methods/mdt/mdt1001/1001.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with a mild, chloroform-like odor.

MW: 165.8	**BP:** 250° F	**FRZ:** -2° F	**Sol:** 0.02%	**VP:** 14 mmHg	**IP:** 9.32 eV
Sp.Gr: 1.62	**Fl.P:** NA	**UEL:** NA	**LEL:** NA		

Noncombustible Liquid, but decomposes in a fire to hydrogen chloride and phosgene.

Incompatibilities & Reactivities Strong oxidizers; chemically-active metals such as lithium, beryllium & barium; caustic soda; sodium hydroxide; potash

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin, nose, throat, respiratory system; nausea; flush face, neck; dizziness, incoordination; headache, drowsiness; skin erythema (skin redness); liver damage; [potential occupational carcinogen]

Target Organs Eyes, skin, respiratory system, liver, kidneys, central nervous system

Cancer Site [in animals: liver tumors]

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet or contaminated	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Change: No recommendation
Provide: Eyewash, Quick drench

Respirator Recommendations

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0076 (/niosh/ipcsneng/neng0076.html) See MEDICAL TESTS: 0179 (/niosh/docs/2005-110/nmed0179.html)

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Toluene

Synonyms & Trade Names Methyl benzene, Methyl benzol, Phenyl methane, Toluol

CAS No. 108-88-3	**RTECS No.** XS5250000 (/niosh-rtecs/XS501BD0.html)	**DOT ID & Guide** 1294 130 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=130) (http://www.cdc.gov/Other/disclaimer.html)
Formula $C_6H_5CH_3$	**Conversion** 1 ppm = 3.77 mg/m³	**IDLH** 500 ppm See: 108883 (/niosh/idlh/108883.html)
Exposure Limits **NIOSH REL** : TWA 100 ppm (375 mg/m³) ST 150 ppm (560 mg/m³) **OSHA PEL** † (nengapdxg.html) : TWA 200 ppm C 300 ppm 500 ppm (10-minute maximum peak)		**Measurement Methods** **NIOSH** 1500 (/niosh/docs/2003-154/pdfs/1500.pdf) , 1501 (/niosh/docs/2003-154/pdfs/1501.pdf) , 3800 (/niosh/docs/2003-154/pdfs/3800.pdf) , 4000 (/niosh/docs/2003-154/pdfs/4000.pdf) ; **OSHA** 111 (http://www.osha.gov/dts/sltc/methods/organic/org111/org111.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid with a sweet, pungent, benzene-like odor.

MW: 92.1	**BP:** 232° F	**FRZ:** -139°F	Sol(74° F): 0.07%	**VP:** 21 mmHg	**IP:** 8.82 eV
Sp.Gr: 0.87	**Fl.P:** 40° F	**UEL:** 7.1%	**LEL:** 1.1%		

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

Incompatibilities & Reactivities Strong oxidizers

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, nose; lassitude (weakness, exhaustion), confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); anxiety, muscle fatigue, insomnia; paresthesia; dermatitis; liver, kidney damage

Target Organs Eyes, skin, respiratory system, central nervous system, liver, kidneys

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately **Skin:** Soap wash promptly

Wash skin: When contaminated **Remove:** When wet (flammable) **Change:** No recommendation	**Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations

NIOSH

Up to 500 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0078 (/niosh/ipcsneng/neng0078.html)
See MEDICAL TESTS: 0232 (/niosh/docs/2005-110/nmed0232.html)

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Trichloroethylene

Synonyms & Trade Names Ethylene trichloride, TCE, Trichloroethene, Trilene		
CAS No. 79-01-6	**RTECS No.** KX4550000 (/niosh-rtecs/KX456D70.html)	**DOT ID & Guide** 1710 160 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=160) (http://www.cdc.gov/Other/disclaimer.html)
Formula $ClCH=CCl_2$	**Conversion** 1 ppm = 5.37 mg/m3	**IDLH** Ca [1000 ppm] See: 79016 (/niosh/idlh/79016.html)
Exposure Limits **NIOSH REL** : Ca See Appendix A (nengapdxa.html) See Appendix C (nengapdxc.html) **OSHA PEL** † (nengapdxg.html) : TWA 100 ppm C 200 ppm 300 ppm (5-minute maximum peak in any 2 hours)		**Measurement Methods** **NIOSH** 1022 (/niosh/docs/2003-154/pdfs/1022.pdf) , 3800 (/niosh/docs/2003-154/pdfs/3800.pdf) ; **OSHA** 1001 (http://www.osha.gov/dts/sltc/methods/mdt/mdt1001/1001.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless liquid (unless dyed blue) with a chloroform-like odor.					
MW: 131.4	**BP:** 189° F	**FRZ:** -99°F	**Sol:** 0.1%	**VP:** 58 mmHg	**IP:** 9.45 eV
Sp.Gr: 1.46	**Fl.P:** ?	UEL (77°F): 10.5%	LEL(77° F): 8%		

Combustible Liquid, but burns with difficulty.

Incompatibilities & Reactivities Strong caustics & alkalis; chemically-active metals (such as barium, lithium, sodium, magnesium, titanium & beryllium)

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin; headache, visual disturbance, lassitude (weakness, exhaustion), dizziness, tremor, drowsiness, nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; [potential occupational carcinogen]

Target Organs Eyes, skin, respiratory system, heart, liver, kidneys, central nervous system

Cancer Site [in animals: liver & kidney cancer]

Personal Protection/Sanitation (See protection codes (protect.html))	**First Aid** (See procedures (firstaid.html)) **Eye:** Irrigate immediately

Skin: Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet or contaminated **Change:** No recommendation **Provide:** Eyewash, Quick drench	**Skin:** Soap wash promptly **Breathing:** Respiratory support **Swallow:** Medical attention immediately

Respirator Recommendations

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0081 (/niosh/ipcsneng/neng0081.html) See MEDICAL TESTS: 0236 (/niosh/docs/2005-110/nmed0236.html)

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Search the Pocket Guide

SEARCH

Enter search terms separated by spaces.

Fluorotrichloromethane

Synonyms & Trade Names Freon® 11, Monofluorotrichloromethane, Refrigerant 11, Trichlorofluoromethane, Trichloromonofluoromethane

CAS No. 75-69-4	**RTECS No.** PB6125000 (/niosh-rtecs/PB5D75C8.html)	**DOT ID & Guide**
Formula CCl_3F	**Conversion** 1 ppm = 5.62 mg/m3	**IDLH** 2000 ppm See: 75694 (/niosh/idlh/75694.html)
Exposure Limits **NIOSH REL** : C 1000 ppm (5600 mg/m3) **OSHA PEL** † (nengapdxg.html) : TWA 1000 ppm (5600 mg/m3)		**Measurement Methods** **NIOSH** 1006 (/niosh/docs/2003-154/pdfs/1006.pdf) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless to water-white, nearly odorless liquid or gas (above 75°F).

MW: 137.4	**BP:** 75° F	**FRZ:** -168°F	Sol(75° F): 0.1%	**VP:** 690 mmHg	**IP:** 11.77 eV
Sp.Gr: 1.47 (Liquid at 75°F)	**Fl.P:** NA	**UEL:** NA	**LEL:** NA	**RGasD:** 4.74	

Noncombustible Liquid Nonflammable Gas

Incompatibilities & Reactivities Chemically-active metals such as sodium, potassium, calcium, powdered aluminum, zinc, magnesium & lithium shavings; granular barium

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms incoordination, tremor; dermatitis; cardiac arrhythmias, cardiac arrest; asphyxia; liquid: frostbite

Target Organs Skin, respiratory system, cardiovascular system

Personal Protection/Sanitation (See protection codes (protect.html))
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: No recommendation
Remove: When wet or contaminated
Change: No recommendation
Provide: Eyewash, Quick drench

First Aid (See procedures (firstaid.html))
Eye: Irrigate immediately
Skin: Water flush immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations
NIOSH/OSHA

Up to 2000 ppm:
(APF = 10) Any supplied-air respirator
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0047 (/niosh/ipcsneng/neng0047.html) See MEDICAL TESTS: 0258 (/niosh/docs/2005-110/nmed0258.html)

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Enter search terms separated by spaces.

Vinyl chloride

Synonyms & Trade Names Chloroethene, Chloroethylene, Ethylene monochloride, Monochloroethene, Monochloroethylene, VC, Vinyl chloride monomer (VCM)

CAS No. 75-01-4	**RTECS No.** KU9625000 (/niosh-rtecs/KU92DDA8.html)	**DOT ID & Guide** 1086 116P (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx?guide=116&poly=1) (http://www.cdc.gov/Other/disclaimer.html) (inhibited)
Formula CH_2=CHCl	**Conversion** 1 ppm = 2.56 mg/m3	**IDLH** Ca [N.D.] See: IDLH INDEX (/niosh/idlh/intridl4.html)
Exposure Limits **NIOSH REL** : Ca See Appendix A (nengapdxa.html) **OSHA PEL** : [1910.1017] TWA 1 ppm C 5 ppm [15-minute]		**Measurement Methods** **NIOSH** 1007 (/niosh/docs/2003-154/pdfs/1007.pdf) ; **OSHA** 4 (http://www.osha.gov/dts/sltc/methods/organic/org004/org004.html) (http://www.cdc.gov/Other/disclaimer.html) , 75 (http://www.osha.gov/dts/sltc/methods/organic/org075/org075.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless gas or liquid (below 7°F) with a pleasant odor at high concentrations. [Note: Shipped as a liquefied compressed gas.]

MW: 62.5	**BP:** 7°F	**FRZ:** -256° F	Sol(77° F): 0.1%	**VP:** 3.3 atm	**IP:** 9.99 eV
	Fl.P: NA (Gas)	**UEL:** 33.0%	**LEL:** 3.6%	**RGasD:** 2.21	

Flammable Gas

Incompatibilities & Reactivities Copper, oxidizers, aluminum, peroxides, iron, steel [Note: Polymerizes in air, sunlight, or heat unless stabilized by inhibitors such as phenol. Attacks iron & steel in presence of moisture.]

Exposure Routes inhalation, skin and/or eye contact (liquid)

Symptoms lassitude (weakness, exhaustion); abdominal pain, gastrointestinal bleeding; enlarged liver; pallor or cyanosis of extremities; liquid: frostbite; [potential occupational carcinogen]

Target Organs Liver, central nervous system, blood, respiratory system, lymphatic system

Cancer Site [liver cancer]

Personal Protection/Sanitation (See protection codes (protect.html)) **Skin:** Frostbite **Eyes:** Frostbite	**First Aid** (See procedures (firstaid.html)) **Eye:** Frostbite **Skin:** Frostbite **Breathing:** Respiratory support

Wash skin: No recommendation
Remove: When wet (flammable)
Change: No recommendation
Provide: Frostbite wash

Respirator Recommendations
(See Appendix E) (nengapdxe.html)

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection (pgintrod.html#mustread)

See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0082 (/niosh/ipcsneng/neng0082.html)
See MEDICAL TESTS: 0241 (/niosh/docs/2005-110/nmed0241.html)

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APPENDIX D3

JOB SAFETY ANALYSIS

LANGAN ENGINEERING & ENVIRONMENTAL SERVICES	**DATE:** 10/17/12 **REVISION DATE:** N/A	**OFFICE:** San Francisco **PROJECT MANAGER:** Joshua Graber **SAFETY OFFICER:** Christina Simmons
SITE: Texas Instruments, Incorporated, Santa Clara Campus **JOB TITLE OR TASK:** Conduct building survey and inventory	**PERSON(S) PERFORMING JOB:** Joshua Graber and Christina Simmons With USEPA and TI Representatives	**ANALYSIS BY:** Christina Simmons **REVIEWED BY:** Joshua Graber Anthony Moffa

REQUIRED PERSONAL PROTECTIVE EQUIPMENT (PPE) AND/OR PERTINENT JOB SAFETY FORMS:	
Minimum PPE:	Close-toed shoes, high visibility vest
Additional PPE (as needed):	Steel-toed boots, long-sleeved shirt, nitrile gloves, safety glasses, hard hat, cut-resistant or work gloves, Tyvek sleeves
Monitoring Equipment:	Photo-ionization detector (PID)
Job Safety Form:	Safety Briefings Form

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE OR CORRECTIVE ACTION
1. Daily Tailgate Safety Meeting	1. None	1. All employees assigned to this task will attend a daily tailgate safety meeting, which will include the pertinent JSA's, Standard Operating Procedures (SOPs), types of potential hazards, and actual hazards present and controls for those hazards.
2. Calibration of monitoring equipment	1. None	1. None
3. Air monitoring using PID	1. None	1. None
4. All activities	1. Slips, Trips, and Falls	1a. All personnel should be constantly watching for trip hazards, such as uneven terrain, holes, ditches, stretched wires or ropes or other materials in their path 1b. Proper housekeeping of materials during sampling events 1c. Mark significant below-grade hazards (i.e. holes, trenches) with safety cones or spray paint 1d. Wear proper footwear for terrain and scope of work (steel-toe boots) 1e. Rainy, snowy, or icy conditions will warrant a more cautious work attitude. Employees should change work speed and style to fit the weather conditions

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE OR CORRECTIVE ACTION
4. All activities (continued)	2. Hand injuries during manual handling of materials (Continued)	2a. Workers should inspect materials for jagged or sharp edges, and rough or slippery surfaces 2b. Workers should keep fingers away from pinch and shear points, especially when setting down materials 2c. Workers should wipe off greasy, wet, slippery or dirty objects before attempting to handle them 2d. Cut-resistant gloves should be worn at all times except when the gloves create a hindrance to completing the task in a safe manner or compromise sample integrity
	3. Foot injuries	3. Steel-toed boots should be used for protection of the feet
	4. Back injuries	4a. All three main factors in manual lifting (load location, task repetition, and load weight) must be considered when evaluating what is safe or unsafe to lift; obtain assistance when possible 4b. All manual lifting of heavy or bulky objects shall be carefully planned to avoid injuries or damage to equipment
	5. Vehicular traffic	5. Employees shall wear high-visibility shirts or safety vests when performing work in high traffic areas; use cones where appropriate to designate work area; notify building occupants and fork lift operators of work areas
	6. Wildlife a. Stray animals b. Mice/rats c. Vectors (i.e. mosquitoes, bees, etc.)	6a. Employees shall be aware of their surroundings at all times, including the presence of wildlife 6b. Employees shall not approach any stray animals 6c. Employees shall carry/use Halt in the event a stray dog may attack 6d. Use bug spray when needed 6e. Employees shall wear long-sleeve shirts during all activities at the site
	7. Heat Stress/Cold Stress	7. Wear proper attire for weather conditions (sunscreen or protection clothing in sunlight, layers for cold weather); drink plenty of fluids to avoid dehydration; take breaks as necessary to avoid heat/cold stress
	8. Crime	8. Employees shall be aware of the potential for crime

LANGAN ENGINEERING & ENVIRONMENTAL SERVICES	**DATE:** 10/18/12 **REVISION DATE:** N/A	**OFFICE:** San Francisco **PROJECT MANAGER:** Joshua Graber **SAFETY OFFICER:** Mukta Patil
SITE: Texas Instruments, Incorporated, Santa Clara Campus **JOB TITLE OR TASK:** Conduct sub-slab soil gas sampling	**PERSON(S) PERFORMING JOB:** Mukta Patil and Adam Brown Alternate: Christina Simmons	**ANALYSIS BY:** Christina Simmons **REVIEWED BY:** Joshua Graber Anthony Moffa

REQUIRED PERSONAL PROTECTIVE EQUIPMENT (PPE) AND/OR PERTINENT JOB SAFETY FORMS:	
Minimum PPE:	Steel-toed boots, high visibility vest, long-sleeved shirt, nitrile gloves, safety goggles, hard hat
Additional PPE (as needed):	Cut-resistant or work gloves
Monitoring Equipment:	Photo-ionization detector (PID)
Job Safety Form:	Safety Briefings Form

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE OR CORRECTIVE ACTION
1. Daily Tailgate Safety Meeting	1. None	1. All employees assigned to this task will attend a daily tailgate safety meeting, which will include the pertinent JSA's, Standard Operating Procedures (SOPs), types of potential hazards, and actual hazards present and controls for those hazards.
2. Move equipment to work site	1. Back strain when lifting heavy equipment	1a. Use proper lifting technique (use legs for bending and lifting and not the back). Use wheeled transport for heavy equipment. Get assistance when handling loads greater than 50 lbs. 1b. Minimize distance to vehicle
	2. Slips/trips/falls while moving equipment	2a. Use proper lifting technique (use legs for bending and lifting and not the back). Use wheeled transport for heavy equipment. Get assistance when handling loads greater than 50 lbs. 2b. Minimize distance to vehicle 2c. Have unobstructed path to vehicle or collection point 2d. Do not lift/walk with boxes that are heavy/difficult to lift
	3. Traffic (if applicable)	3. Wear high visibility vests and exercise caution.
3. Calibration of monitoring equipment	1. None	1. None
4. Air monitoring using PID	1. None	1. None

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE OR CORRECTIVE ACTION
5. Drill hole through the slab and approximately 1-inch into the underlying soil to form a void.	1. Obstructions and electrical hazards 2. Handtool use: electrical hazards 3. Handtool Use: cuts and lacerations 4. Handtool use: flying debris. Handtools have the potential for producing flying debris or dust that can cause eye injury. 5. Chemical Exposure: volatile organic compounds may be present beneath slab.	1. Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding. 2. Ensure handtools are in proper working condition and that cords are intact. Do not use handtools with frayed or repaired cords. 3. Use handtools according to the manufacturer's instruction manual. 4. Wear proper PPE during handtool operation (safety glasses). 5a. Ensure well ventilated work area. 5b. Monitor air using PID (Alert level = 1000 ppb)
6. Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.	1. Cuts and lacerations. 2. Chemical Exposure: volatile organic compounds may be present beneath slab.	1. Wear proper PPE (cut resistant gloves) while clearing drill cuttings. 2a. Ensure well ventilated work area. 2b. Monitor air using PID (Alert level = 1000 ppb)
7. Collect Sample	1. Pinches	1. Wear proper PPE (cut-resistant gloves)
8. Decontaminate equipment	1. Splashed decontamination water/debris on face/eyes 2. Back strain while decontaminating geoprobe rods and augers 3. Injury from high-pressure washer 4. Injury from faulty decontamination equipment	1. Wear proper PPE (safety glasses) 2. Use proper lifting/bending technique (use legs for bending and lifting and not the back); obtain assistance if needed 3. Wear proper PPE (cut-resistant gloves, safety glasses); be aware of pressure 4. Contractor shall inspect all equipment prior to use
9. Pack up equipment	1. Back strain when lifting heavy equipment	1a. Use proper lifting technique (use legs for bending and lifting and not the back). Use wheeled transport for heavy equipment. Get assistance when handling loads greater than 50 lbs. 1b. Minimize distance to vehicle

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE OR CORRECTIVE ACTION
10. Pack up equipment (Continued)	2. Slips/trips/falls while moving equipment	2a. Use proper lifting technique (use legs for bending and lifting and not the back). Use wheeled transport for heavy equipment. Get assistance when handling loads greater than 50 lbs. 2b. Minimize distance to vehicle 2c. Have unobstructed path to vehicle or collection point 2d. Do not lift/walk with boxes that are heavy/difficult to lift
	3. Traffic (if applicable)	3. Wear high visibility vests and exercise caution.
12. All activities	1. Slips, Trips, and Falls	1a. All personnel should be constantly watching for trip hazards, such as uneven terrain, holes, ditches, stretched wires or ropes or other materials in their path 1b. Proper housekeeping of materials during sampling events 1c. Mark significant below-grade hazards (i.e. holes, trenches) with safety cones or spray paint 1d. Wear proper footwear for terrain and scope of work (steel-toe boots) 1e. Rainy or icy conditions will warrant a more cautious work attitude. Employees should change work speed and style to fit the weather conditions
	2. Hand injuries during manual handling of materials	2a. Workers should inspect materials for jagged or sharp edges, and rough or slippery surfaces 2b. Workers should keep fingers away from pinch and shear points, especially when setting down materials 2c. Workers should wipe off greasy, wet, slippery or dirty objects before attempting to handle them 2d. Cut-resistant gloves should be worn at all times except when the gloves create a hindrance to completing the task in a safe manner

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE OR CORRECTIVE ACTION
8. All activities (continued)	3. Foot injuries	3. Steel-toed boots should be used for protection of the feet
	4. Back injuries	4a. All three main factors in manual lifting (load location, task repetition, and load weight) must be considered when evaluating what is safe or unsafe to lift; obtain assistance when possible 4b. All manual lifting of heavy or bulky objects shall be carefully planned to avoid injuries or damage to equipment
	5. Vehicular traffic	5. Employees shall wear high-visibility shirts or safety vests when performing work in high traffic areas; use cones where appropriate to designate work area; notify building occupants and fork lift operators of work areas
	6. Wildlife a. Stray animals b. Mice/rats c. Vectors (i.e. mosquitoes, bees, etc.)	6a. Employees shall be aware of their surroundings at all times, including the presence of wildlife 6b. Employees shall not approach any stray animals 6c. Employees shall carry/use Halt in the event a stray dog may attack 6d. Use bug spray when needed 6e. Employees shall wear long-sleeve shirts during all activities at the site
	7. Heat Stress/Cold Stress	7. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather); drink plenty of fluids to avoid dehydration; take breaks as necessary to avoid heat/cold stress
	8. Crime	8. Employees shall be aware of the potential for crime.

LANGAN ENGINEERING & ENVIRONMENTAL SERVICES	**DATE:** 10/17/12 **REVISION DATE:** N/A	**OFFICE:** San Francisco **PROJECT MANAGER:** Joshua Graber **SAFETY OFFICER:** Mukta Patil
SITE: Texas Instruments, Incorporated, Santa Clara Campus **JOB TITLE OR TASK:** Conduct indoor air and ambient air sampling	**PERSON(S) PERFORMING JOB:** Mukta Patil and Adam Brown Alternate: Christina Simmons	**ANALYSIS BY:** Christina Simmons **REVIEWED BY:** Joshua Graber Anthony Moffa

REQUIRED PERSONAL PROTECTIVE EQUIPMENT (PPE) AND/OR PERTINENT JOB SAFETY FORMS:	
Minimum PPE:	Close-toed shoes, high visibility vest
Additional PPE (as needed):	Steel-toed boots, long-sleeved shirt, nitrile gloves, safety glasses, hard hat, cut-resistant or work gloves, Tyvek sleeves
Monitoring Equipment:	Photo-ionization detector (PID)
Job Safety Form:	Safety Briefings Form

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE OR CORRECTIVE ACTION
1. Daily Tailgate Safety Meeting	1. None	1. All employees assigned to this task will attend a daily tailgate safety meeting, which will include the pertinent JSA's, Standard Operating Procedures (SOPs), types of potential hazards, and actual hazards present and controls for those hazards.
2. Calibration of monitoring equipment	1. None	1. None
3. Air monitoring using PID	1. None	1. None
4. Collect sample.	1. Pinches	1. Wear proper PPE (cut resistant gloves)
5. All activities	1. Slips, Trips, and Falls	1a. All personnel should be constantly watching for trip hazards, such as uneven terrain, holes, ditches, stretched wires or ropes or other materials in their path 1b. Proper housekeeping of materials during sampling events 1c. Mark significant below-grade hazards (i.e. holes, trenches) with safety cones or spray paint 1d. Wear proper footwear for terrain and scope of work (steel-toe boots) 1e. Rainy, snowy, or icy conditions will warrant a more cautious work attitude. Employees should change work speed and style to fit the weather conditions

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE OR CORRECTIVE ACTION
5. All activities (continued)	2. Hand injuries during manual handling of materials (Continued)	2a. Workers should inspect materials for jagged or sharp edges, and rough or slippery surfaces 2b. Workers should keep fingers away from pinch and shear points, especially when setting down materials 2c. Workers should wipe off greasy, wet, slippery or dirty objects before attempting to handle them 2d. Cut-resistant gloves should be worn at all times except when the gloves create a hindrance to completing the task in a safe manner or compromise sample integrity
	3. Foot injuries	3. Steel-toed boots should be used for protection of the feet
	4. Back injuries	4a. All three main factors in manual lifting (load location, task repetition, and load weight) must be considered when evaluating what is safe or unsafe to lift; obtain assistance when possible 4b. All manual lifting of heavy or bulky objects shall be carefully planned to avoid injuries or damage to equipment
	5. Vehicular traffic	5. Employees shall wear high-visibility shirts or safety vests when performing work in high traffic areas; use cones where appropriate to designate work area; notify building occupants and fork lift operators of work areas
	6. Wildlife a. Stray animals b. Mice/rats c. Vectors (i.e. mosquitoes, bees, etc.)	6a. Employees shall be aware of their surroundings at all times, including the presence of wildlife 6b. Employees shall not approach any stray animals 6c. Employees shall carry/use Halt in the event a stray dog may attack 6d. Use bug spray when needed 6e. Employees shall wear long-sleeve shirts during all activities at the site
	7. Heat Stress/Cold Stress	7. Wear proper attire for weather conditions (sunscreen or protection clothing in sunlight, layers for cold weather); drink plenty of fluids to avoid dehydration; take breaks as necessary to avoid heat/cold stress
	8. Crime	8. Employees shall be aware of the potential for crime

APPENDIX D4

SAFETY BRIEFING FORM

SAFETY BRIEFING

Date: _____Time: _____Leader: _____Location: _____

Work Task: _____

SAFETY TOPICS (*provide some detail of discussion points*)

Chemical Exposure Hazards and Control _____

Physical Hazards and Control _____

Air Monitoring _____

PPE _____

Communications _____

Safe Work Practices _____

Emergency Response _____

Hospital/Medical Center Location _____

Phone Nos. _____

Other _____

FOR FOLLOW-UP (the issues, responsibilities, due dates, etc.)

_____

_____

_____

ATTENDEES

PRINT NAME	COMPANY	SIGNATURE

Briefing Conducted By: _____

APPENDIX D5

CALIBRATION LOG

DATE:_____ **PROJECT:**_____

CALIBRATION LOG

Time	Inst Type	Inst #	Media	Initial Reading	Span #	Calib Reading	Performed By:

APPENDIX D6

AIR MONITORING RECORDS

AIR MONITORING FIELD DATA SHEET

DATE	TIME	SAMPLE LOCATION	BREATHING ZONE PID READING (PPM)

APPENDIX D7

DECONTAMINATION PROCEDURES

PERSONNEL DECONTAMINATION

LEVEL A DECONTAMINATION

Station 1:	Equipment Drop	1. Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, cool down stations may be set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	2. Scrub outer boots, outer gloves and fully-encapsulating suit with decon solution or detergent and water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	3. Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Tank Change	4. If worker leaves Exclusion Zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.
Station 5:	Boot, Gloves and Outer Garment Removal	5. Boots, fully-encapsulating suit, inner gloves removed and deposited in separate containers lined with plastic.
Station 6:	SCBA Removal	6. SCBA backpack and facepiece is removed (avoid touching face with fingers). SCBA deposited on plastic sheets.
Station 7:	Field Wash	7. Hands and face are thoroughly washed. Shower as soon as possible.

LEVEL B DECONTAMINATION

Station 1:	Equipment Drop	1. Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, cool down stations may be set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	2. Scrub outer boots, outer gloves and chemical-resistant splash suit with decon solution or detergent and water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	3. Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Tank Change	4. If worker leaves Exclusion Zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.
Station 5:	Boot, Gloves and Outer Garment Removal	5. Boots, chemical-resistant splash suit, inner gloves removed and deposited in separate containers lined with plastic.
Station 6:	SCBA Removal	6. SCBA backpack and facepiece is removed (avoid touching face with fingers). SCBA deposited on plastic sheets.
Station 7:	Field Wash	7. Hands and face are thoroughly washed. Shower as soon as possible.

LEVEL C DECONTAMINATION

Station 1:	Equipment Drop	1. Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, cool down stations may be set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	2. Scrub outer boots, outer gloves and chemical-resistant splash suit with decon solution or detergent and water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	3. Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Canister or Mask Change	4. If worker leaves Exclusion Zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.
Station 5:	Boot, Gloves and Outer Garment Removal	5. Boots, chemical-resistant splash suit, inner gloves removed and deposited in separate containers lined with plastic.
Station 6:	Facepiece Removal	6. Facepiece is removed (avoid touching face with fingers). Facepiece deposited on plastic sheets.
Station 7:	Field Wash	7. Hands and face are thoroughly washed. Shower as soon as possible.

LEVEL D DECONTAMINATION

Station 1:	Equipment Drop	1. Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, cool down stations may be set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	2. Scrub outer boots, outer gloves and chemical-resistant splash suit with decon solution or detergent and water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	3. Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Boot, Gloves and Outer Garment Removal	4. Boots, chemical-resistant splash suit, inner gloves removed and deposited in separate containers lined with plastic.
Station 5:	Field Wash	5. Hands and face are thoroughly washed. Shower as soon as possible.

EQUIPMENT DECONTAMINATION

GENERAL:

Equipment to be decontaminated during the project may include tools, monitoring equipment, respirators, sampling containers, laboratory equipment and drilling equipment.

All decontamination will be done by personnel in protective gear, appropriate for the level of decontamination, as determined by the site HSO. The decontamination work tasks will be split or rotated among support and work crews.

Depending on site conditions, backhoe and pumps may be decontaminated over a portable decontamination pad to contain wash water; or, wash water may be allowed to run off into a storm sewer system. Equipment needed may include a steam generator with high-pressure water, empty drums, screens, screen support structures, and shovels. Drums will be used to hold contaminated wash water pumped from the lined pit. These drums will be labeled as such.

Miscellaneous tools and equipment will be dropped into a plastic pail, tub, or other container. They will be brushed off and rinsed with a detergent solution, and finally rinsed with clean water.

MONITORING EQUIPMENT:

Monitoring equipment will be protected as much as possible from contamination by draping, masking, or otherwise covering as much of the instruments as possible with plastic without hindering the operation of the unit. The HNu or OVA meter, for example, can be placed in a clear plastic bag, which allows reading of the scale and operation of knobs. The probes can be partially wrapped keeping the sensor tip and discharge port clear.

The contaminated equipment will be taken from the drop area and the protective coverings removed and disposed in the appropriate containers. Any dirt or obvious contamination will be brushed or wiped with a disposable paper wipe.

RESPIRATORS:

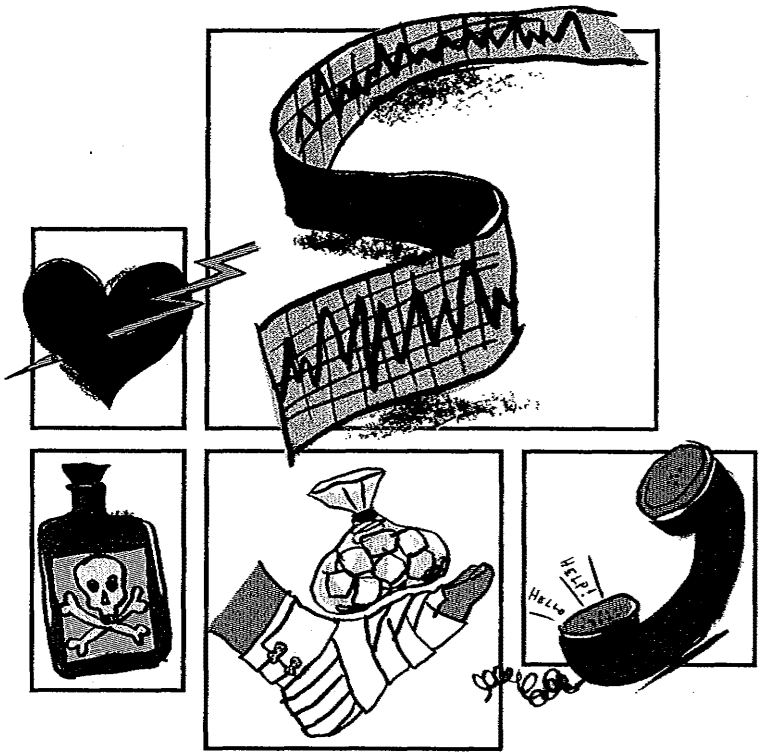
Respirators will be cleaned and disinfected after every use. Taken from the drop area, the masks (with the cartridges removed and disposed of with other used disposable gear) will be immersed in a cleaning solution and scrubbed gently with a soft brush, followed by a rinse in plain warm water, and then allowed to air dry. In the morning, new cartridges will be installed. Personnel will inspect their own masks for serviceability prior to donning them. And, once the mask is on, the wearer will check the respirator for leakage using the negative and positive pressure fit check techniques.

APPENDIX D8

NATIONAL SAFETY COUNCIL EMERGENCY FIRST AID GUIDE

National Safety Council

EMERGENCY
FIRST AID GUIDE



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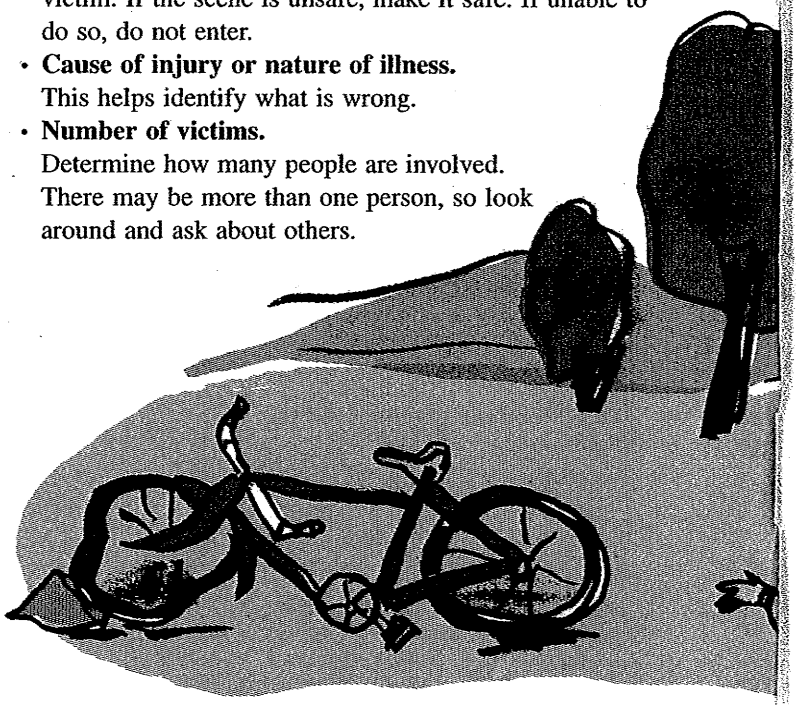
CONTENTS

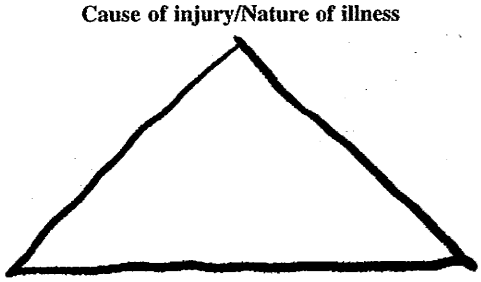
SCENE SURVEY

Most people sustain a significant injury sometime during their lives. Therefore, all of us should be able to give first aid because we will eventually find ourselves in a situation requiring it—either for another person or for ourselves.

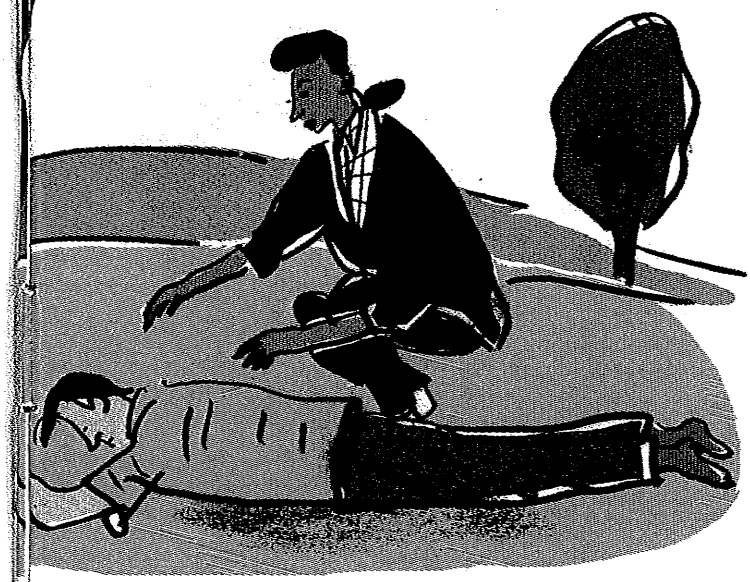
When approaching the scene of an emergency, do a 10-second scene survey to find out about:

- **Danger to rescuer and victim.**
  Scan the area for immediate dangers to yourself or to the victim. If the scene is unsafe, make it safe. If unable to do so, do not enter.
- **Cause of injury or nature of illness.**
  This helps identify what is wrong.
- **Number of victims.**
  Determine how many people are involved. There may be more than one person, so look around and ask about others.





If there are 2 or more victims, first check those who are not moving or talking. These are the individuals who need your help first.



GETTING HELP

ACTION AT AN EMERGENCY

When to call for help . . .

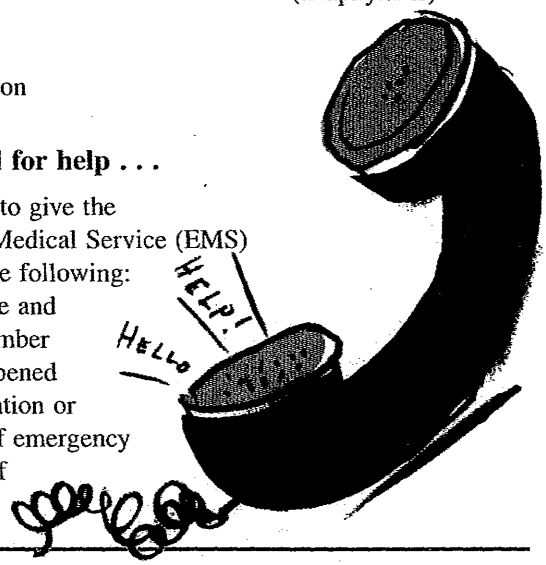
If the victim is experiencing or has experienced:

- no breathing or breathing difficulty
- cardiac arrest
- uncontrolled bleeding
- heart attack
- stroke (also known as brain attack)
- altered mental status
- unconsciousness
- drowning
- choking
- electrocution
- poisoning
- attempted suicide
- some cases of seizures
- diabetic emergencies
- severe burns
- paralysis
- possible spine injury
- severe allergic reaction (anaphylaxis)

How to call for help . . .

Be prepared to give the Emergency Medical Service (EMS) dispatcher the following:

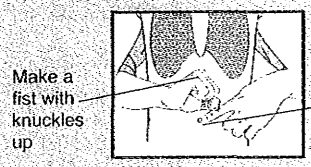
- your name and phone number
- what happened
- exact location or address of emergency
- number of victims

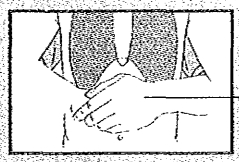


ALERT DO NOT hang up until the dispatcher hangs up—the EMS dispatcher may be able to tell you how to care for the victim until the ambulance arrives.

CONSCIOUS CHOKING MANAGEMENT

1. Determine if the person is choking. Ask "Are you choking?" A choking person is unable to breathe, talk, cry, or cough.
2. Position yourself behind the victim to give abdominal thrusts (also known as the Heimlich maneuver). Locate hand position for giving thrusts.





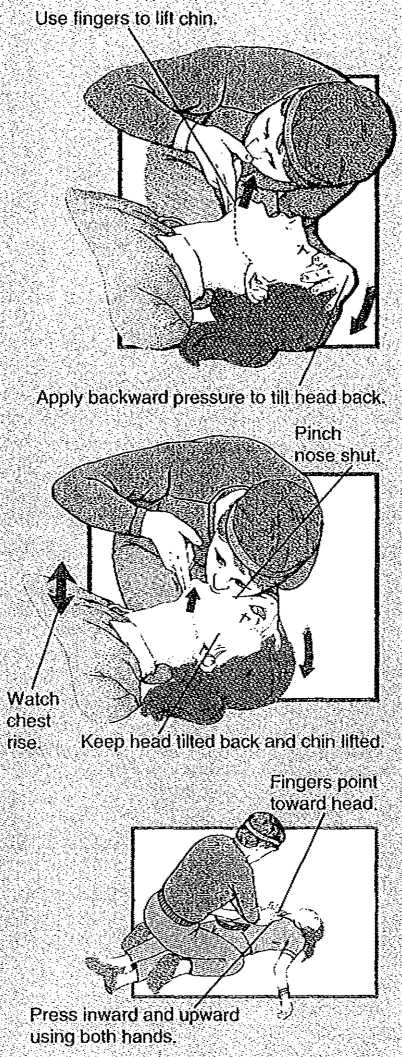
3. Give up to 5 quick abdominal thrusts. After every 5 thrusts, check victim and your technique for effectiveness.

Repeat cycles of 5 abdominal thrusts until object is expelled or victim becomes unconscious.

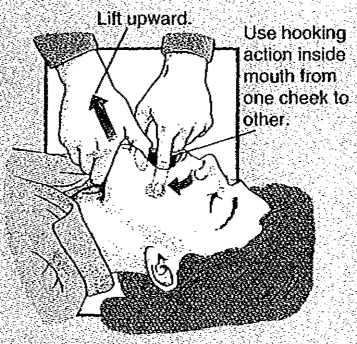
RESUSCITATION

UNCONSCIOUS CHOKING MANAGEMENT

1. Check for responsiveness by tapping victim and shouting "Are you OK?" If no response, call EMS.
2. Open airway using the head-tilt/chin-lift method. If you suspect a spine injury, use only chin lift. Check for breathing by looking at the chest and listening and feeling for breaths.
3. If victim is not breathing, give 2 slow breaths. If first breath does not go in, retilt the person's head and try a second breath.
4. Give up to 5 abdominal thrusts (Heimlich maneuver).



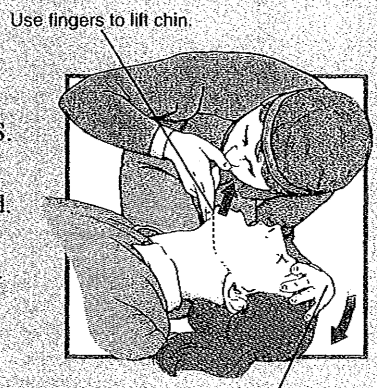
5. Do a finger sweep (for a child, sweep only if you see the object).
6. Open airway and try a breath (if breath goes in, see number 4, page 10).
7. If breath does not go in, repeat cycles of 5 thrusts, finger sweep, and 1 breath.



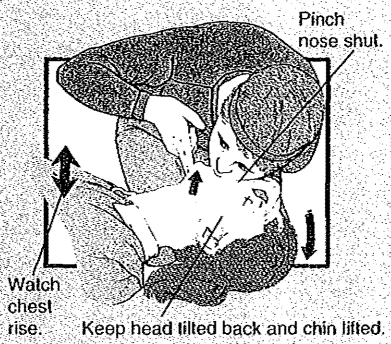
ALERT Using disposable latex gloves and a mouth-to-barrier device is recommended.

RESCUE BREATHING AND CPR

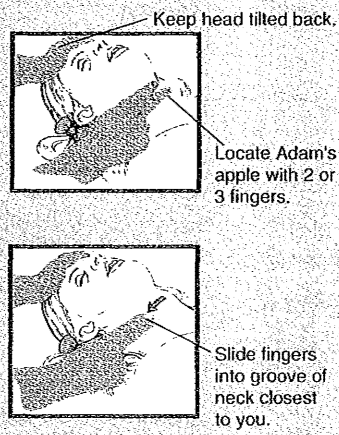
1. Check for responsiveness by tapping victim and shouting "Are you OK?" If no response, call EMS.
2. Open airway using the head-tilt/chin-lift method. If you suspect a spine injury, use only chin lift. Check for breathing by looking at the chest and listening and feeling for breaths.



3. If victim is not breathing, give 2 slow breaths. If first breath does not go in, retilt the person's head and try a second breath. (If second breath does not go in, go to number 4, page 8.)



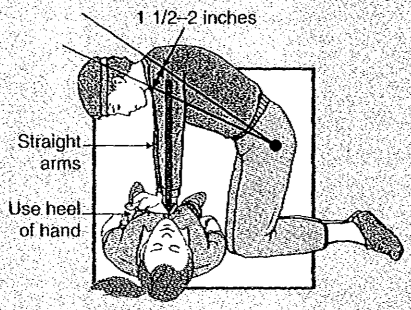
4. If 2 breaths went in, check the neck pulse (carotid) for 5 to 10 seconds:
   - **If neck pulse is present but victim is not breathing,** give 1 slow breath about every 5 seconds for an adult (give 1 breath every 3 seconds for a child). See if victim's chest is rising and falling with each breath.



RESUSCITATION

ALERT Using disposable latex gloves and a mouth-to-barrier device is recommended.

- **If there is no neck pulse,** start CPR by giving 15 compressions (rate of 80 to 100 times per minute).
- Give 2 slow breaths.
- Repeat cycles of 15 compressions and 2 breaths.
- After about 1 minute, recheck pulse for about 5 seconds. If there is still no pulse, continue CPR beginning with chest compressions.



For a child (1–8 years):

If you are alone, call EMS after 1 minute of resuscitation rather than after determining responsiveness.

- Give chest compressions with 1 hand (rather than 2).
- Do not compress chest as deep.
- Give 1 breath after every 5 chest compressions (rather than 2 breaths after every 15 chest compressions).

ANIMAL BITES

1. Use direct pressure to control bleeding.
2. If bleeding is not heavy or if bleeding has stopped, wash bite wound with soap and water.
3. Flush the bite wound with water under pressure from faucet. Control bleeding if it restarts after flushing.
4. Cover the bite with a sterile dressing or clean cloth.
5. Seek medical attention.

ALERT DO NOT close the wound with tape because bacteria may become trapped, resulting in infection. Pack large, gaping wounds with sterile gauze pads.

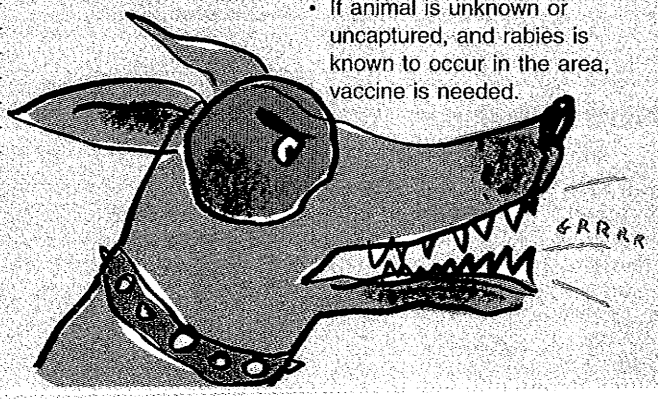
Check wound daily for signs of infection.

Consider possibility of rabid animal if:

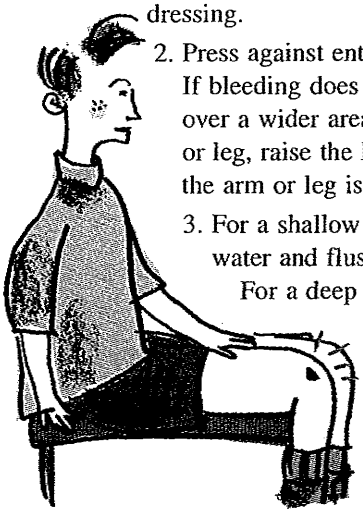
- animal attack unprovoked
- animal acted strange
- animal was a high-risk species (bat, raccoon, or skunk)

What should you do about the animal?

- If the animal was killed, send entire body to veterinarian or state health lab for exam.
- If animal is known, confine and observe for 10 days.
- If animal is unknown or uncaptured, and rabies is known to occur in the area, vaccine is needed.



BLEEDING



1. Cover entire wound with clean, dry cloth or sterile dressing.
2. Press against entire wound for 5–10 minutes. If bleeding does not slow or stop, press harder over a wider area. If bleeding is from an arm or leg, raise the limb above heart level unless the arm or leg is broken.
3. For a shallow wound, wash it with soap and water and flush with forceful, running water. For a deep wound, do not use soap and water, but flush with water under pressure. Deep wounds require cleaning by a medically trained person. Pack large, gaping wounds with sterile gauze pads.
4. When bleeding stops or subsides, secure gauze or cloth snugly with a bandage. For a shallow wound, antibiotic ointment can be applied before the dressings. Do not use antibiotic ointment on a deep wound.

ALERT

Protect yourself against diseases carried by blood by wearing disposable latex gloves, using several layers of cloth or gauze pads, using waterproof material such as plastic, or having the victim apply pressure with his or her own hand.

DO NOT remove a blood-soaked dressing, since clotting may be affected. Instead, place another dressing over the blood-soaked one.

BLISTERS

If blister is unbroken and not very painful:

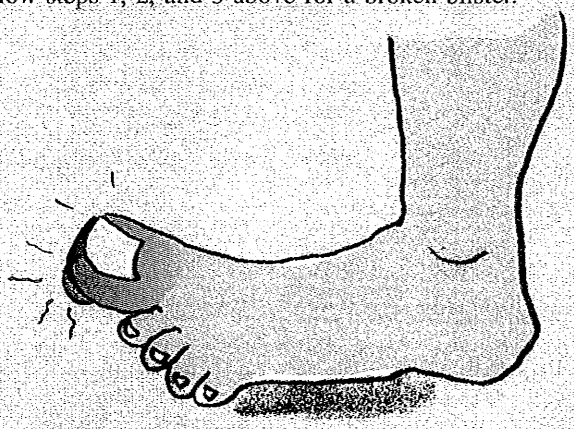
1. Cut doughnut-shaped holes in several gauze pads, moleskin, or molefoam to fit around blister.
2. Tape doughnut-shaped pads in place.

If blister is broken:

1. Clean area with soap and water.
2. Apply antibiotic ointment.
3. Apply doughnut-shaped pads around blister and cover them with an uncut gauze pad.

If blister is very painful and affects walking:

1. Drain fluid from blister by making several small holes with a sterilized needle.
2. Follow steps 1, 2, and 3 above for a broken blister.

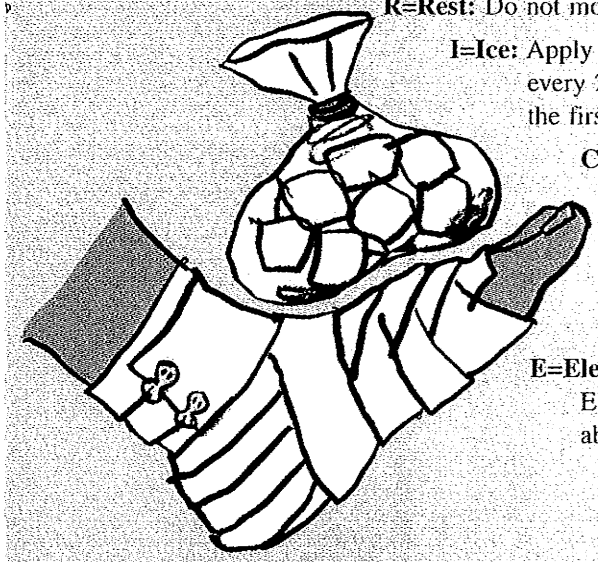


ALERT DO NOT remove blister's roof unless it is torn or very painful and affects walking.

BONE, JOINT, AND MUSCLE INJURIES

Victim may be unable to move or use injured body part and injured part may also be: deformed, tender, and/or swollen.

Use RICE procedure:



R=Rest: Do not move injured part.

I=Ice: Apply ice for 20 minutes every 2–3 hours during the first 24–48 hours.

C=Compression: Compress injured area with elastic bandage when not applying ice pack applications.

E=Elevation: Elevate injured part above heart level.

ALERT

If you suspect a broken bone or dislocated joint:

- Stabilize the injured part by tying it against either the victim's body or a rigid object (e.g., board) to prevent movement.
- DO NOT try to straighten a deformity or replace a protruding bone.
- Seek medical attention.
- If you suspect a spine injury, broken hip, pelvis, or thigh, DO NOT move victim. See page 30 for spine injury.

BREATHING DIFFICULTY

For asthma:

1. Keep victim sitting up.
2. If victim has doctor-prescribed hand-held inhaler, victim should:
   - exhale deeply
   - place lips around inhaler's opening
   - depress inhaler as inhalation begins
   - hold breath for several seconds
3. Give victim clear liquids to drink.

ALERT Call EMS for severe, prolonged cases.

For hyperventilation:

1. Reassure and calm victim.
2. Encourage victim to take long, slow breaths and to hold each breath before slowly exhaling.

ALERT DO NOT have victim breathe into a paper bag.

COMMON EMERGENCIES

For severe allergic reaction (anaphylaxis):

1. Call EMS immediately.
2. If victim has a doctor-prescribed epinephrine auto-injector, assist the victim in injecting epinephrine:
   - press injector against victim's thigh to inject epinephrine dose
   - hold injector against thigh for 10 seconds
3. Keep checking victim.

NOTE: For mild reaction, give an over-the-counter antihistamine.

BURNS

1. Stop the burning! Use water or smother flames.
2. Cool the burn. Apply cool water or cool, wet cloths until pain decreases (usually within 10–40 minutes). Do not apply cold to more than the area equivalent to the size of the victim's entire chest or back (about 20% of body surface area).
3. Cover the burn with clean, dry cloth or sterile dressing. Non-stick dressings are the best on burns.

ALERT DO NOT remove any clothing sticking to the burned area.
Remove jewelry such as rings, watches, and bracelets.

Seek medical attention if any of these conditions exist:

- breathing difficulty
- head, hands, feet, or genitals involved
- victim's age is under 5 or over 60 years
- involves electricity or chemical (see below)
- second-degree burns (has blisters) cover more than an area equivalent to size of victim's entire back or chest
- any third degree burns

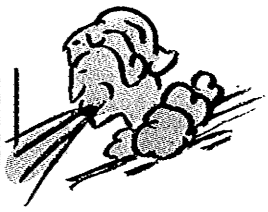
Chemical burns:

- if possible, protect your skin and eyes
- if a dry powder, brush off before flushing with water
- flush with large amounts of water for at least 15–20 minutes. You can't use enough water on chemical burns.

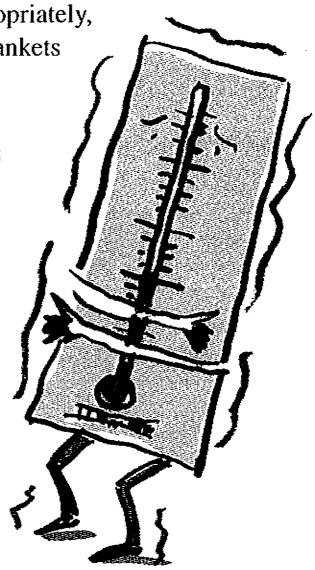
Electrical burns:

- check scene for electrical hazards
- check breathing and pulse since CPR may be needed

COLD-RELATED INJURIES



1. Stop the heat loss! Remove victim from cold environment; replace wet clothing; cover victim's head since 50% of body heat is lost through head.
2. Handle victim very gently. Avoid rough handling.
3. If victim is alert and responding appropriately, insulate by wrapping victim in dry blankets or sleeping bag and allow victim's shivering to rewarm.
4. If victim's skin over the stomach feels cool and the victim is unresponsive or not responding appropriately:
   - wrap in warm blankets
   - call EMS to transport victim since severe hypothermics should be rewarmed only in a hospital setting

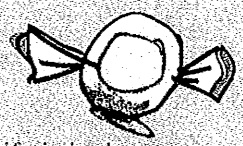


ALERT

DO NOT allow victim to walk or exert. If victim is unresponsive, check pulse for 30–45 seconds to determine the need for CPR.

DO NOT massage or rub arms or legs. For frostbite (frozen skin), rewarm part in warm water (no hotter than 106 degrees F), elevate affected part, and seek medical attention. If a thermometer is not available, test the water with your elbow. The water temperature should be similar to that used in a hot bathtub.

DIABETIC EMERGENCIES



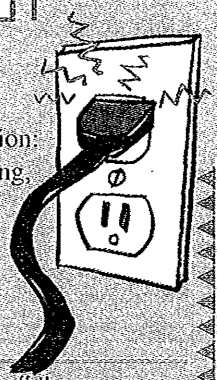
Suspect a diabectic emergency if victim has altered mental status and a history of diabetes.

1. If victim is awake enough to swallow, give some food or drink containing sugar.

   Examples: table sugar, soda, candy, or fruit juice. If oral glucose (comes as a tube of gel) is available, place it between the victim's cheek and gum.

2. If victim is not better in 10–15 minutes, call EMS.

ELECTROCUTIONS

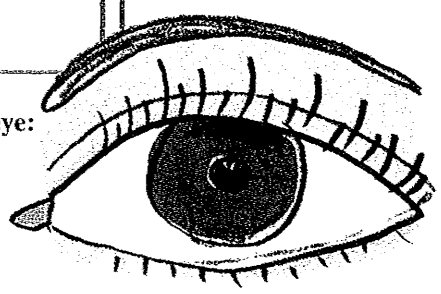


1. Make sure area is safe before entering area or touching victim.
2. Check the victim's breathing and circulation:
   - If victim has a pulse but is not breathing, start rescue breathing (see page 9).
   - If victim is not breathing and has no pulse, start CPR (see page 9).
3. Seek medical attention immediately.

ALERT

Either unplug, disconnect, or turn off the power affecting the victim. If this is impossible, call the power company or EMS for help. They have trained personnel and the proper equipment. DO NOT use another object (not even wood) to separate wires and victims.

EYE INJURIES



If object is stuck in victim's eye:

1. Do not remove object.
2. Protect eye to prevent object being driven deeper into the eye.
3. Seek medical attention immediately.

If chemical is in victim's eye:

1. Hold injured eye open.
2. Flush with water for 15–20 minutes. Turn head to side so injured eye is below uninjured eye. Water will flush chemical away from uninjured eye.
3. Loosely bandage eye.
4. Seek medical attention immediately.

If loose object is in victim's eye, try the following procedures in this order:

1. Pull upper eyelid down and over lower lid.
2. Pull lower lid down and look at inner surface while victim looks up. If object is seen, remove it by either flushing with water or with a clean, moistened cloth or sterile dressing.
3. Lift upper eyelid over match stick. If object is seen, remove it by either flushing with water or with a clean, moistened cloth or sterile dressing.

ALERT

Movement of the good eye causes movement of the injured eye, so bandaging both eyes is suggested.

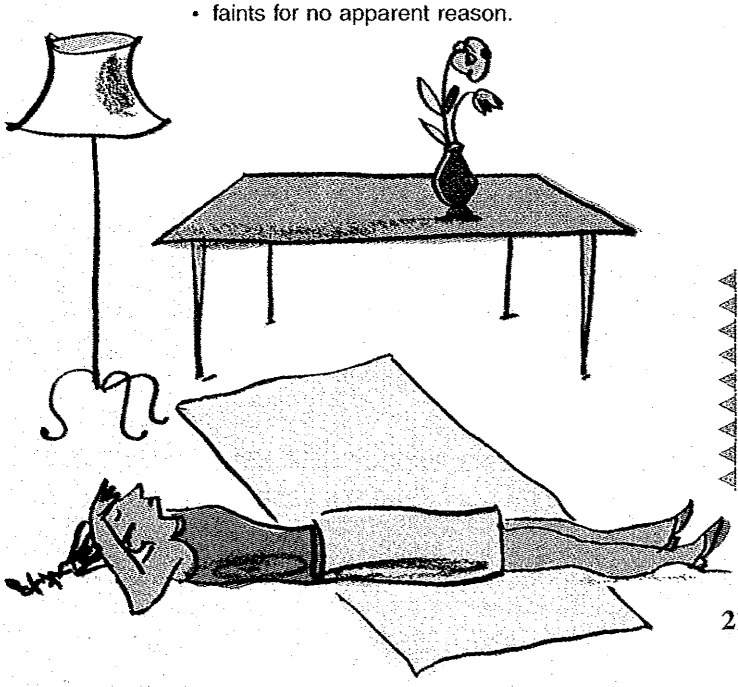
DO NOT apply pressure on injured eye.

FAINTING

1. Check breathing and pulse.
2. Roll unconscious victim onto side.
3. Loosen tight clothing.
4. If victim fell, check for injuries.

ALERT Seek medical attention if the victim:

- is over 40 years old.
- has had repeated attacks of unconsciousness or fainting.
- does not waken within 5 minutes.
- lost consciousness while sitting or lying down.
- faints for no apparent reason.

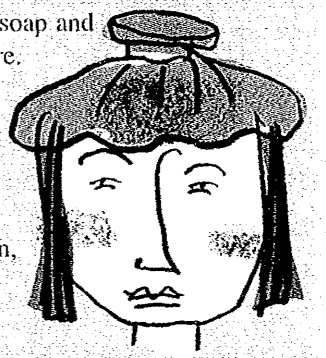


HEAD INJURIES

Lay victim down while keeping victim's head and shoulders slightly raised.

For bleeding scalp:

1. Control bleeding with direct pressure. For suspected skull fracture, apply pressure on the outside edges of wound.
2. For shallow scalp wound, wash with soap and water. Flush with water under pressure.



For swelling and pain:

Apply an ice pack for 15–20 minutes.

For motionless victim:

1. Check breathing and pulse.
2. Place on left side to keep airway open, drain fluids, and prevent vomiting.

ALERT

Suspect spine injury with all blows to the head.

During the night, wake victim every 2 hours. If no response or if victim responds poorly to being asked to repeat numbers, seek medical attention.

If any of the following appears within 48 hours of the injury, seek medical attention:

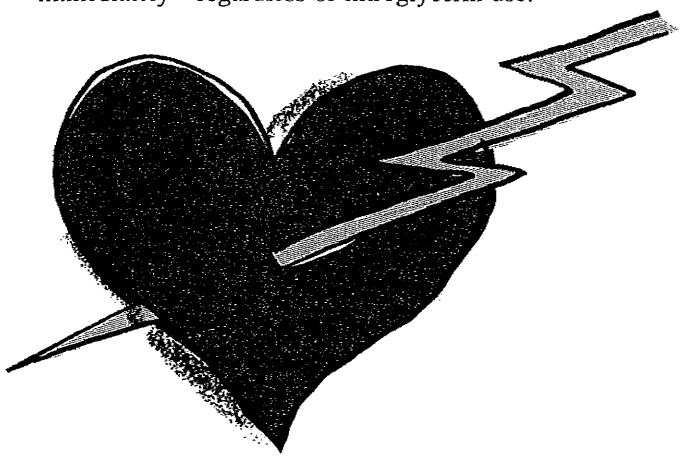
- headache lasting more than 1 to 2 days
- headache worsens
- nausea and vomiting
- vision problems
- speech affected
- unsteady walking
- seizures or convulsions

HEART ATTACK (CHEST PAIN)

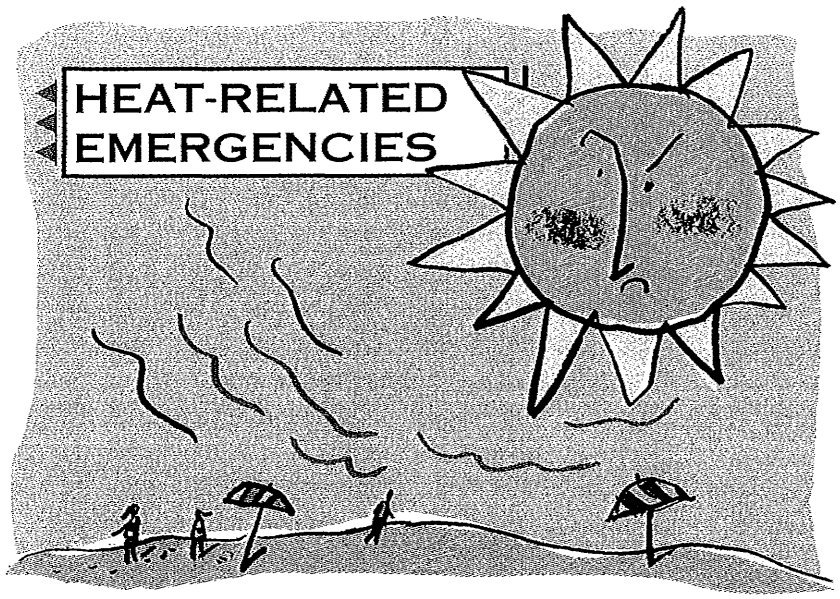
It is difficult to determine a heart attack. These warning signs often occur:

- pressure, squeezing, or pain in the center of the chest
- pain spreading to shoulders, neck, or arms
- lightheadedness, fainting, sweating, nausea, or shortness of breath

1. Place victim in comfortable position, usually in half-sitting position with knees bent. Ask victim what position feels the best and relieves any breathing difficulty.
2. If victim has doctor-prescribed nitroglycerin tablets or under-the-tongue spray:
   - help the victim take 1 dose
   - repeat in 3–5 minutes with maximum of 3 doses in 10 minutes
3. If no relief of chest pain in 10 minutes, call EMS immediately—regardless of nitroglycerin use.



HEAT-RELATED EMERGENCIES



Remove victim from the hot environment and place in a cool, shaded environment.

For heat exhaustion (moist, normal skin temperature):

1. Loosen or remove excess clothing.
2. Sponge with cool water and fan victim.
3. If victim can swallow and is not nauseated, give cool, lightly salted water or commercial sports drink.

For heat stroke (hot skin and altered mental status):

1. Call EMS immediately. This is a life-threatening emergency.
2. Remove excess clothing.
3. Start cooling the victim immediately:
   - If in low humidity (less than 75%): spray, sprinkle, or pour water on skin and vigorously fan victim.
   - If in high humidity (more than 75%): place cold or ice packs on neck, armpits, groin.

INSECT STINGS

For a honeybee:

1. Look for a stinger embedded in skin. Only honeybees leave a stinger embedded. A venom sac may also be attached.
2. If stinger is found, scrape or brush it out with a long fingernail, credit card, scissor edge, or knife blade.
3. Follow steps 1 and 2 below.

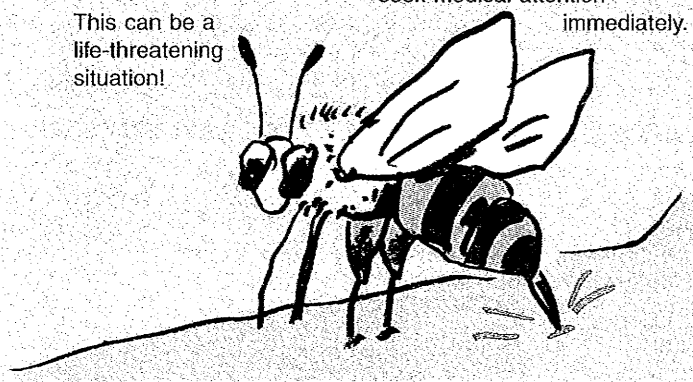
For all insect stings and bites:

1. Wash stung area with soap and water.
2. Apply ice pack for 15–20 minutes.

ALERT If honeybee venom sac is still attached to stinger, pulling with tweezers or fingers squeezes more venom into victim.

Observe victim for 30 minutes for signs of an allergic reaction. Should breathing be affected, ask the victim if he or she has a doctor-prescribed emergency kit containing epinephrine. Assist victim in injecting epinephrine (see page 16), and seek medical attention immediately.

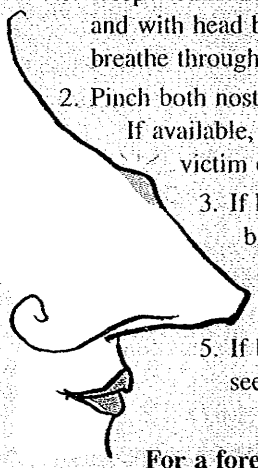
This can be a life-threatening situation!



NOSE INJURIES

For a nosebleed:

1. Keep victim in sitting position leaning slightly forward and with head bent slightly forward. Remind victim to breathe through the mouth.
2. Pinch both nostrils with steady pressure for 5–10 minutes. If available, wear disposable latex gloves. If able, the victim can do the pinching.
3. If bleeding continues, have victim gently blow nose to remove clots and excess blood, and to minimize sneezing.
4. Pinch both nostrils again for 5 minutes.
5. If bleeding continues more than 30 minutes, seek medical attention.



For a foreign object:

1. If object is visible, try to remove it with tweezers.
2. If object can't be removed:
   - Have victim gently blow the affected nostril while pressing the other nostril, or
   - Induce sneezing by having victim sniff pepper.
3. If unsuccessful, seek medical attention.

If victim received a blow to the nose and the nose appears crooked:

1. Care for nosebleed.
2. Apply ice pack to nose for 15 minutes to reduce swelling and pain.
3. Seek medical attention.

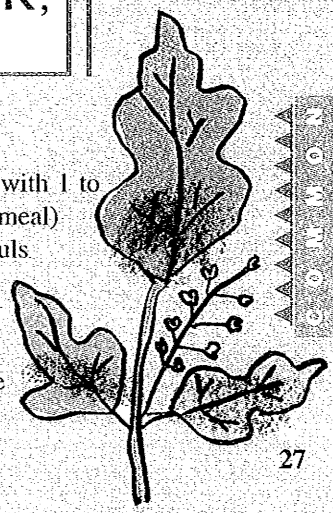
ALERT! For unconscious victim, place on side to prevent inhalation of blood.

POISON, SWALLOWED

1. Remove any objects from victim's mouth.
2. Try to determine what poison was swallowed and how much.
3. Call the poison control center immediately for instructions (70% of all poison cases can be handled over the phone).
4. Keep victim on the left side to delay poison emptying into the small intestine where it gets into the bloodstream faster.

ALERT If victim complains about sensations of burning or you see burns around the mouth, immediately give milk or water.

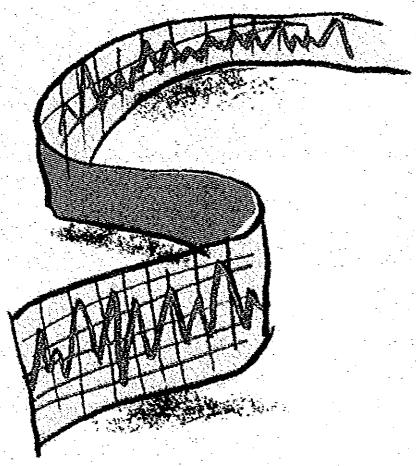
POISON IVY, OAK, AND SUMAC



1. For itching, use any of these:
   - Calamine lotion
   - Lukewarm bathwater sprinkled with 1 to 2 cups of Aveeno (colloidal oatmeal)
   - Baking soda paste (3 teaspoonfuls of baking soda mixed in 1 teaspoon of water)
   - Immerse area in hot water (do not burn skin). This releases the substances causing the itching.
2. For swelling and blisters, use doctor-prescribed medications.

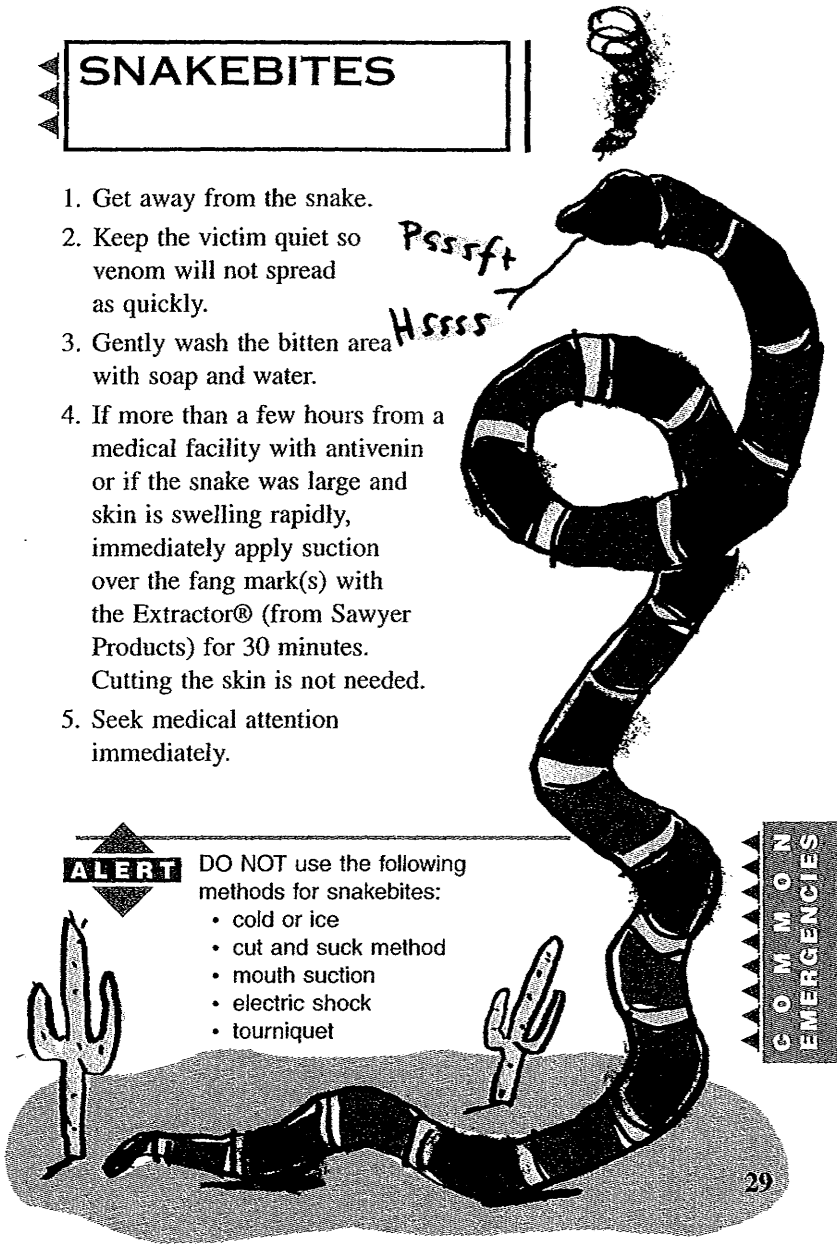
SEIZURES/ CONVULSIONS

1. Cushion victim's head with something soft.
   Remove nearby objects to prevent injury.
2. Turn victim onto side.
3. Look for a medical alert identification.
4. After seizure stops, keep victim on his or her side and offer your help.
   Most seizures are not medical emergencies.
5. Call EMS when:
   - seizures last more than 5 minutes or if a second seizure occurs
   - no medical alert identification about "epilepsy" or "seizure disorder" found
   - any signs of injury or illnesses are seen
   - pregnancy or other medical condition is identified



SNAKEBITES

1. Get away from the snake.
2. Keep the victim quiet so venom will not spread as quickly.
3. Gently wash the bitten area with soap and water.
4. If more than a few hours from a medical facility with antivenin or if the snake was large and skin is swelling rapidly, immediately apply suction over the fang mark(s) with the Extractor® (from Sawyer Products) for 30 minutes. Cutting the skin is not needed.
5. Seek medical attention immediately.



ALERT DO NOT use the following methods for snakebites:

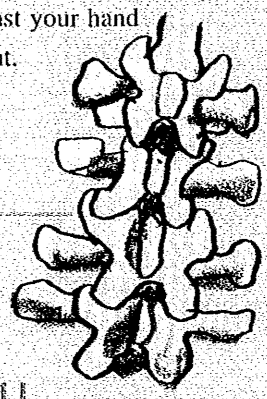
- cold or ice
- cut and suck method
- mouth suction
- electric shock
- tourniquet

SPINE INJURIES

Follow steps 1–3 if victim cannot:

- feel pinching of fingers or toes
- wiggle fingers or toes
- squeeze your hand or push foot against your hand

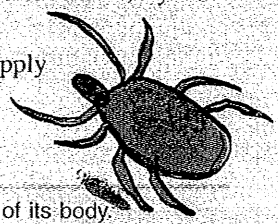
1. Stabilize victim against any movement. Tell victim not to move.
2. Keep checking breathing and pulse.
3. Call EMS.



ALERT DO NOT move victim unless endangered. Wait for trained EMS personnel with proper equipment.

TICK EMBEDDED

1. Gently pull tick out with tweezers. Grasp tick's head as close to the skin as possible. A small piece of the victim's skin may also be removed. If mouth parts remain, try to remove with a sterile needle.
2. Wash bite site with soap and water. Apply rubbing alcohol to disinfect the area.
3. Apply ice pack to reduce pain.



ALERT DO NOT grab tick at the rear of its body.
DO NOT twist or jerk the tick while pulling it out.
DO NOT use these ineffective methods:

- petroleum jelly
- fingernail polish

- rubbing alcohol
- petroleum products such as gasoline
- blown-out hot match

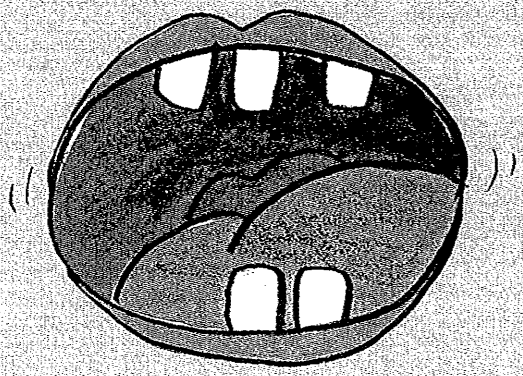
Watch for signs of infection or unexplained symptoms (such as severe headache, fever, or rash) that may develop 3 to 30 days later. If such symptoms occur, seek medical attention immediately.

TOOTH KNOCKED-OUT

1. Stop bleeding by placing a moistened gauze pad in empty tooth socket. Tell victim to bite down on it.
2. Save permanent tooth by either:
   - reinserting the tooth at the accident scene if more than 30 minutes from a dentist, or
   - preserving tooth and taking it to a dentist in either whole milk, a container of saliva, or inside victim's cheek
3. Seek a dentist.

ALERT

DO NOT scrub the knocked-out tooth.
DO NOT put the tooth in mouthwash, alcohol, or water.
DO NOT remove partly knocked-out tooth.



National Safety Council

EMERGENCY TELEPHONE NUMBERS

LOCAL EMERGENCY NUMBER (USUALLY 9-1-1):

POISON CONTROL CENTER:

DOCTOR'S NAME AND NUMBER:

DENTIST'S NAME AND NUMBER:

POLICE:

FIRE:

NAME AND NUMBER OF MEDICAL FACILITY WITH 24-HOUR CARE:

NEIGHBOR'S NAME AND NUMBER:

RELATIVE'S NAME AND NUMBER:

YOUR HOME

ADDRESS:

NUMBER:

NEAREST INTERSECTION OR LANDMARK:

AVAILABLE FROM

NATIONAL SAFETY COUNCIL
1121 Spring Lake Drive
Itasca, IL 60143
800–621–7615
Product Number 19412–0000

JONES AND BARTLETT PUBLISHERS
40 Tall Pine Drive
Sudbury, MA 01776
800–832–0034
ISBN: 0-86720-543-1

APPENDIX D9

EMPLOYEE EXPOSURE/INJURY INCIDENT REPORT

INCIDENT REPORT

LANGAN EMPLOYEE EXPOSURE/INJURY INCIDENT REPORT
(Submit a Separate Report for Each Employee and/or Incident)

Date: _____

Employee Name:_____ Employee No:_____

Sex: M _____ F _____ Age: _____

Region: _____ Location:_____

Project: _____ Project No: _____

Incident:_____

Type: Possible Exposure _____ Exposure _____ Physical Injury _____

Location: _____

Date of Incident: _____ Time of Incident: _____

Date of Report Incident: _____

Person(s) to Whom Incident was Reported: _____

Weather Conditions During Incident: Temperature _____ Humidity _____

Wind Speed and Direction: _____ Cloud Cover: _____

Clear: _____ Precipitation: _____

Materials Potentially Encountered: _____

Chemical (give name of description - liquid, solid, gas, vapor, fume, mist):

_____

_____

Radiological:_____

Other: _____

Nature of the Exposure/Injury: (State the nature of the exposure/injury in detail and list the parts of the body affected. Attach extra sheets if necessary).

_____

_____

_____

_____

_____

Did you receive medical care? Yes _____ No _____ If so, when _____

Where? On-Site _____ Off-Site _____

By Whom: Name of Paramedic: _____

Name of Physician: _____

Other: _____

If Off-Site, name facility (hospital, clinic, etc):_____

_____

Length of stay at the facility?_____

Was the Site Safety Officer contacted? Yes _____ No _____ When?_____

Was the Corporate Health and Safety Officer contacted? Yes _____ No _____

If so, who was the contact?_____

Did the exposure/injury result in permanent disability? Yes _____ No _____

If so, explain:_____

_____

_____

_____

Has the employee returned to work? Yes _____ No _____

List the names of other persons affected during this incident:

_____

_____

_____

_____

List the names of persons who witnessed the exposure/injury incident:

_____

_____

_____

_____

_____

_____

_____

Possible cause of the exposure/injury incident: _____

_____

_____

_____

_____

_____

What was the name and title of the field team leader or immediate supervisor at the site of the incident?

_____

Was the operation being conducted under an established Health and Safety Plan?

Yes _____ No _____ If yes, attach a copy. If no, explain

_____

_____

_____

_____

Describe protective equipment and clothing used by the employee:

_____

_____

_____

_____

_____

_____

Did any limitations in safety equipment or protective clothing contribute to or affect exposure? If so, explain:

_____

_____

What was the employee doing when the exposure/injury occurred? (Describe briefly as Site Reconnaissance, Site Characterization, or Sampling, etc.):

_____

_____

_____

_____

_____

_____

Where exactly on site or off site did the exposure/injury occur?

_____

_____

_____

_____

_____

How did the exposure/injury occur? (Describe fully what factors led up to and/or contributed to the incident):

_____

_____

_____

_____

_____

Name of person(s) initiating report, job title, phone number:

_____

_____

_____

_____

_____ _____

Employee Signature Date

_____ _____

Site Safety Officer Signature or Field Team Leader Signature Date